Bull Trout (*Salvelinus confluentus*)

Draft Recovery Plan

CHAPTER 1: Introduction

(October 2002)

Region 1
U.S. Fish and Wildlife Service
Portland, Oregon

Approved:______XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

Regional Director

Date:________________________

DISCLAIMER

Recovery plans delineate reasonable actions that are believed necessary to recover and protect listed species. Plans are prepared by the U.S. Fish and Wildlife Service, sometimes with the assistance of recovery teams, contractors, State agencies, Tribal agencies, and others. Objectives will be attained and any necessary funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Recovery plans do not necessarily represent the views nor the official positions or approval of any individuals or agencies involved in plan formulation, other than the U.S. Fish and Wildlife Service. Recovery plans represent the official position of the U.S. Fish and Wildlife Service only after they have been signed by the Director or Regional Director as approved. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks.

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The Bull Trout Recovery Team gratefully acknowledges the numerous individuals who participated on recovery unit teams. Those who contributed to the recovery unit teams are listed in the chapters for each recovery unit.

EXECUTIVE SUMMARY FOR THE BULL TROUT RECOVERY PLAN

Current Species Status

The bull trout (*Salvelinus confluentus*) in the coterminous United States was listed as threatened on November 1, 1999 (64 FR 58910). Earlier rulemakings had listed distinct population segments of bull trout as threatened in the Columbia River, Klamath River, and Jarbidge River basins (63 FR 31647, 63 FR 42757, 64 FR 17110). Bull trout distribution, abundance, and habitat quality have declined rangewide. Several local extirpations have been documented, beginning in the 1950's. Bull trout continue to occur the Klamath River, Columbia River, Jarbidge River, St. Mary-Belly River, and Coastal-Puget Sound, in the states of Idaho, Montana, Nevada, Oregon, and Washington.

Habitat Requirements and Limiting Factors

Bull trout have more specific habitat requirements than most other salmonids. Habitat components that influence bull trout distribution and abundance include water temperature, cover, channel form and stability, substrate for spawning and rearing, and migratory corridors. Bull trout are found in colder streams and require colder water than most other salmonids for incubation, juvenile rearing, and spawning. Spawning and rearing areas are often associated with cold-water springs, groundwater infiltration, and/or the coldest streams in a watershed. Throughout their lives, bull trout require complex forms of cover, including large woody debris, undercut banks, boulders, and pools. Alterations in channel form and reductions in channel stability result in habitat degradation and reduced survival of bull trout eggs and juveniles. Channel alterations may reduce the abundance and quality of side channels, stream margins, and pools, which are areas bull trout frequently inhabit. For spawning and early rearing bull trout require loose, clean gravel relatively free of fine sediments. Because bull trout have a relatively long incubation and development period within spawning gravel (greater than 200 days), transport of bedload in unstable channels may kill young bull trout. Bull trout use migratory corridors to move from spawning and rearing habitats to foraging and overwintering habitats and back. Different habitats provide bull trout with diverse resources, and migratory corridors allow local populations to connect, which may increase the potential for gene flow and support or refounding of populations.

Declines in bull trout distribution and abundance are the results of combined effects of the following: habitat degradation and fragmentation, the blockage of migratory corridors, poor water quality, angler harvest and poaching, entrainment (process by which aquatic organisms are pulled through a diversion structure or other device) into diversion channels and dams, and introduced nonnative species. Specific land and water management activities that continue to depress bull trout populations and degrade habitat include dams and other diversion structures, forest management practices, livestock grazing, agriculture, road construction and maintenance, mining, and urban and rural development. Some threats to bull trout are the continuing effects of past land management activities.

Organization and Development of the Recovery Plan

Because bull trout in the coterminous United States are widely distributed within a large area, the recovery plan is organized into multiple chapters. This introductory chapter (Chapter 1) describes our overall recovery strategy for the species, defines recovery, and identifies recovery actions applicable for all listed bull trout in the coterminous United States. Each successive chapter focuses on bull trout in specific geographic areas (recovery units), and describes conditions, defines recovery criteria, and identifies specific recovery actions for the recovery unit.

Recovery Objectives

The goal of this recovery plan is to describe the actions needed to achieve the recovery of bull trout, that is, to ensure the long-term persistence of self-sustaining, complex interacting groups (or multiple local populations that may have overlapping spawning and rearing areas) of bull trout distributed across the species' native range. Recovery of bull trout will require reducing threats to the long-term persistence of populations, maintaining multiple interconnected populations of bull trout across the diverse habitats of their native range, and preserving the diversity of bull trout life-history strategies (*e.g.*, resident or migratory forms, emigration age, spawning frequency, local habitat adaptations). To recover bull trout, the following four objectives have been identified:

- Maintain current distribution of bull trout within core areas as described in recovery unit chapters and restore distribution where recommended in recovery unit chapters.

- Maintain stable or increasing trend in abundance of bull trout.

- Restore and maintain suitable habitat conditions for all bull trout life history stages and strategies.

- Conserve genetic diversity and provide opportunity for genetic exchange.

These objectives apply to bull trout in all recovery units. Additional objectives may be necessary to achieve recovery in some recovery units and will be identified in the respective recovery unit chapters.

Recovery Criteria

Criteria are established to assess whether recovery objectives are being achieved. Criteria specific to each recovery unit are defined in each recovery unit chapter. Individual chapters may contain criteria for assessing the status of bull trout and alleviation of threats that are unique to one or several recovery units. However, every recovery unit chapter will contain criteria that address the following characteristics:

- The **distribution of bull trout** in identified and potential local populations in all core areas within the recovery unit.
- The **estimated abundance of adult bull trout** within core areas in the recovery unit, expressed as either a point estimate or a range of individuals.
- The **presence of stable or increasing trends** for adult bull trout abundance in the recovery unit.
- The **restoration of passage** at specific barriers identified as inhibiting recovery.

We expect recovery of bull trout to be a dynamic process occurring over time. The recovery objectives are based on our current knowledge and may be refined as more information becomes available. Some local populations of bull trout, and possibly core area populations, may be extirpated even though recovery actions are being implemented. If reestablishment of recently extirpated populations is not feasible or practical, recovery criteria for a given recovery unit will be revised on a case-by-case basis. Meeting the four recovery criteria is not intended to be precluded where localized extirpations of bull trout are offset by sufficiently strong improvements in other areas of a recovery unit in meeting the four recovery objectives.

The determination of whether a distinct population segment of bull trout is recovered will rely on an analysis of the overall status of the species, threats to the species, and the adequacy of existing regulatory and conservation mechanisms. For example, it may be possible for the Columbia River Distinct Population Segment, which has 22 recovery units, to be recovered prior to all recovery unit criteria being met in all recovery units. Success in accomplishing the recovery criteria will be reviewed and considered for the impacts both within a recovery unit and throughout a distinct population segment.

Actions Needed

Specific tasks falling within the following seven categories will be necessary to initiate recovery within all recovery units:

- Protect, restore, and maintain suitable habitat conditions for bull trout.
- Prevent and reduce negative effects of nonnative fishes and other nonnative taxa on bull trout.
- Establish fisheries management goals and objectives compatible with bull trout recovery and implement practices to achieve goals.
- Characterize, conserve, and monitor genetic diversity and gene flow among local populations of bull trout.
- Conduct research and monitoring to implement and evaluate bull trout recovery activities, consistent with an adaptive management approach using feedback from implemented, site-specific recovery tasks.
- Use all available conservation programs and regulations to protect and conserve bull trout and bull trout habitats.
- Assess the implementation of bull trout recovery by recovery units and revise recovery unit plans based on evaluations.

Recovery Priority Number

The recovery priority number for bull trout in the coterminous United States is 9C, on a scale of 1 to 18, indicating that (1) taxonomically, these populations are distinct population segments of a species, (2) the five populations are subject to a moderate degree of threat(s), (3) the recovery potential is high, and (4) the degree of potential conflict during recovery is high.

Estimated Cost of Recovery

The total cost estimate of recovery for bull trout in the coterminous United States is presented in the individual recovery unit chapters. The costs presented in each chapter are attributed to bull trout conservation but other species will also benefit.

Date of Recovery

Expected time to achieve recovery varies among recovery units because of differences in bull trout status, factors affecting bull trout, implementation and effectiveness of recovery tasks, and responses to recovery tasks. Achieving bull trout recovery in all recovery units will be a complex process that will likely take 25 years or more.

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WHAT IS A RECOVERY PLAN?

A recovery plan is a template for the recovery of a threatened or endangered species and its habitats. The recovery plan describes a process to remove the threats to the long-term survival and reverse the decline of a listed species. Recovery is the restoration of listed species such that they become secure, self-sustaining components of their ecosystem. For bull trout, recovery will require reducing threats to the long-term persistence of populations, maintaining multiple interconnected populations across the diverse habitats of the native range of bull trout, and preserving the diversity of bull trout life-history strategies (*e.g.*, resident and migratory forms, emigration age, spawning frequency, local habitat adaptations).

An approved recovery plan is not a decision document but is intended to provide information and guidance that the U.S. Fish and Wildlife Service believes will lead to recovery of a listed species, including its habitat. A recovery plan provides information necessary to describe the current status of the listed species as well as ongoing or proposed actions designed to aid in the ultimate recovery of the species. Many of the recovery actions (or tasks) in this document will require further environmental analysis and public review, especially those actions taken by Federal agencies.

DEVELOPMENT AND ORGANIZATION OF THE BULL TROUT RECOVERY PLAN

Because the threatened bull trout population segments are widely distributed over a large area and because population segments were subject to listing at different times, the U.S. Fish and Wildlife Service adopted a two-tiered approach to develop the draft recovery plan for bull trout. The first tier addresses broad aspects of bull trout recovery that apply at the level of population segments. The second tier addresses bull trout recovery in smaller areas, such as specific river basins or collections of river basins within population segments, termed "recovery units". There are 22 recovery units in the Columbia River, 1 in the Klamath River, 1 in the Jarbidge River, 1 in the St. Mary-Belly River, and 2 in the Coastal-Puget Sound Distinct Population Segments. This document includes the Columbia River, Klamath River, and the St. Mary-Belly River segments. Recovery plans for the remaining two segments will be released individually at a later time.

We relied on two types of teams to assist in developing the draft recovery plan. To address overall recovery issues, such as identifying an overall recovery strategy, designating recovery units, and providing guidance in developing the recovery plan, we convened an "overall" recovery team. Membership on the recovery team consisted of U.S. Fish and Wildlife Service biologists, a representative from State fish and wildlife resource agencies in each of the four northwestern states (Idaho, Montana, Oregon, and Washington), and a representative from the Upper Columbia United Tribes (Confederated Tribes of the Colville Reservation, Coeur d'Alene Tribe, Kalispel Tribe, Kootenai Tribe of Idaho, and Spokane Tribe).

To develop local recovery strategies at the recovery unit level, we enlisted the assistance of recovery unit teams, one for each recovery unit. Membership on the recovery unit teams consisted of persons with technical expertise in various aspects of bull trout biology within each recovery unit, typically representing Federal and State agencies, Tribes, and industry and interest groups. Major tasks of recovery unit teams included defining recovery for recovery units, including unit-specific objectives and criteria; reviewing factors affecting bull trout; estimating costs; and identifying site-specific actions. Members of the recovery team coordinated with recovery unit teams to ensure consistency among recovery units (see Figure 1 and Table 1 for recovery units).

Figure 1. Bull trout recovery units in the United States.

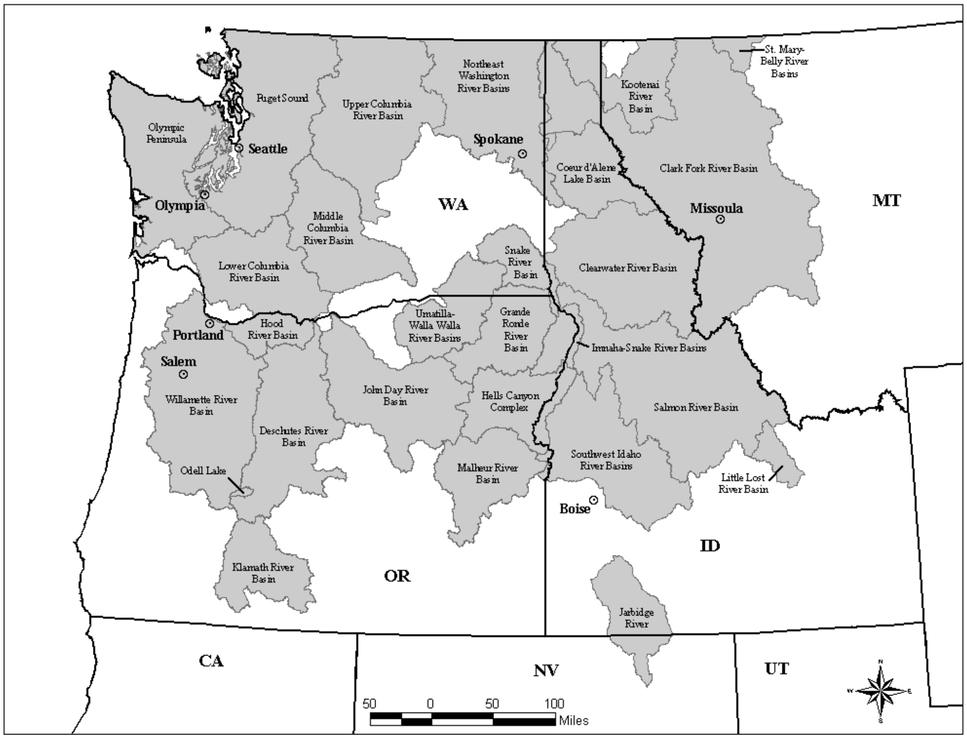


Table 1. Bull trout recovery units by distinct population segment and State(s).

Recovery unit	Distinct population segment	State(s)
Klamath River	Klamath River	Oregon
Clark Fork River	Columbia River	Idaho, Montana, Washington
Kootenai River	Columbia River	Idaho, Montana
Willamette River	Columbia River	Oregon
Hood River	Columbia River	Oregon
Deschutes River	Columbia River	Oregon
Odell Lake	Columbia River	Oregon
John Day River	Columbia River	Oregon
Umatilla-Walla Walla River	Columbia River	Oregon, Washington
Grande Ronde River	Columbia River	Oregon
Imnaha-Snake River[1]	Columbia River	Idaho, Oregon
Hells Canyon Complex[2]	Columbia River	Idaho, Oregon
Malheur River	Columbia River	Oregon
Coeur d'Alene Lake Basin	Columbia River	Idaho
Clearwater River	Columbia River	Idaho

Table 1. Bull trout recovery units by distinct population segment and State(s).

Recovery unit	Distinct population segment	State(s)
Salmon River	Columbia River	Idaho
Southwest Idaho[3]	Columbia River	Idaho
Little Lost River	Columbia River	Idaho
Lower Columbia River[4]	Columbia River	Washington
Middle Columbia River[5]	Columbia River	Washington
Upper Columbia River[6]	Columbia River	Washington
Northeast Washington[7]	Columbia River	Washington
Snake River Washington[8]	Columbia River	Oregon, Washington
Jarbidge River	Jarbidge River	Idaho, Nevada
Puget Sound	Coastal-Puget Sound	Washington
Olympic Peninsula	Coastal-Puget Sound	Washington
St. Mary-Belly River	St. Mary-Belly River	Montana

[1]Includes Imnaha River and Snake River and tributaries in Idaho.
[2]Includes Pine Creek, Powder River, and Snake River and tributaries in Idaho.
[3]Includes Boise River, Payette River, and Weiser River basins.
[4]Includes Klickitat River, Lewis River, and White Salmon River basins.
[5]Includes Yakima River basin.
[6]Includes Entiat River, Methow River, and Wenatchee River basins.
[7]Includes mainstem Columbia River and tributaries upstream of Chief Joseph Dam (Washington), Pend Oreille River basin (Washington), and Spokane River basin upstream to Post Falls (Idaho).
[8]Includes Asotin Creek basin and Tucannon River basin.

The bull trout recovery plan differs from many recovery plans in that it is organized into multiple chapters. This introductory chapter (Chapter 1) discusses programmatic issues that broadly apply to bull trout in the coterminous United States. This chapter describes the U.S. Fish and Wildlife Service's recovery strategy for the species, defines recovery, and identifies recovery tasks applicable to bull trout throughout its range.

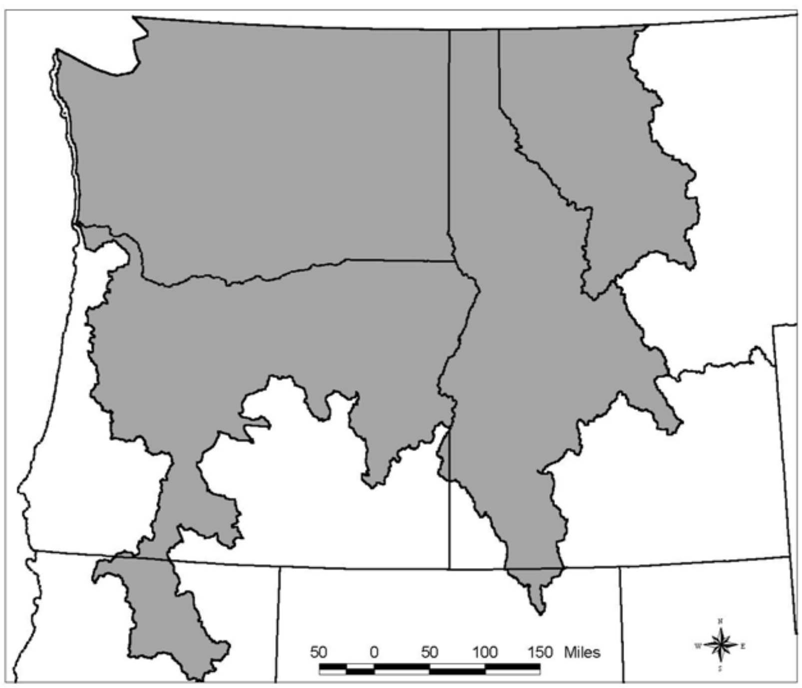
Each following chapter (Chapters 2 through 24 and Chapter 28) addresses a specific recovery unit and includes an executive summary, describes current conditions of the habitat and species within the recovery unit, outlines the strategy for recovery, defines recovery objectives and criteria, identifies specific recovery tasks, and estimates time and cost required to achieve recovery for a particular recovery unit. For a complete list of chapters, see Appendix 4 in this chapter or the last appendix in any of the following chapters.

Many of the states have their own bull trout conservation plans in varying stages of development and implementation. These plans each have unique attributes, but may not meet all statutory requirements for the contents of recovery plans, as described in section 4(f)(1)(B) of the Endangered Species Act including "(i) a description of such site-specific management actions as may be necessary to achieve the plan's goal for the conservation and survival of the species; (ii) objective, measurable criteria which, when met, would result in a determination, in accordance with the provisions of this section, that the species be removed from the list; and (iii) estimates of the time required and the cost to carry out those measures needed to achieve the plan's goal and to achieve intermediate steps toward that goal." The U.S. Fish and Wildlife Service's recovery planning process for bull trout builds upon the foundation established in State conservation plans and adopts portions of those plans, where appropriate.

INTRODUCTION

Bull trout (*Salvelinus confluentus*, family Salmonidae) are char native to the Pacific Northwest and western Canada. The historical range of bull trout includes major river basins in the Pacific Northwest at about 41 to 60 degrees North latitude, from the southern limits in the McCloud River in northern California and the Jarbidge River in Nevada to the headwaters of the Yukon River in the Northwest Territories, Canada (Cavender 1978; Bond 1992). To the west, bull trout range includes Puget Sound, various coastal rivers of British Columbia, Canada, and southeast Alaska (Bond 1992). Bull trout occur in portions of the Columbia River and tributaries within the basin, including its headwaters in Montana and Canada. Bull trout also occur in the Klamath River basin of south-central Oregon. East of the Continental Divide, bull trout are found in the headwaters of the Saskatchewan River in Alberta and Montana and in the MacKenzie River system in Alberta and British Columbia, Canada, (Cavender 1978; Brewin and Brewin 1997). The historical range of bull trout in the coterminous United States is shown in Figure 2.

Figure 2. Estimated historical range of bull trout in the coterminous United States.

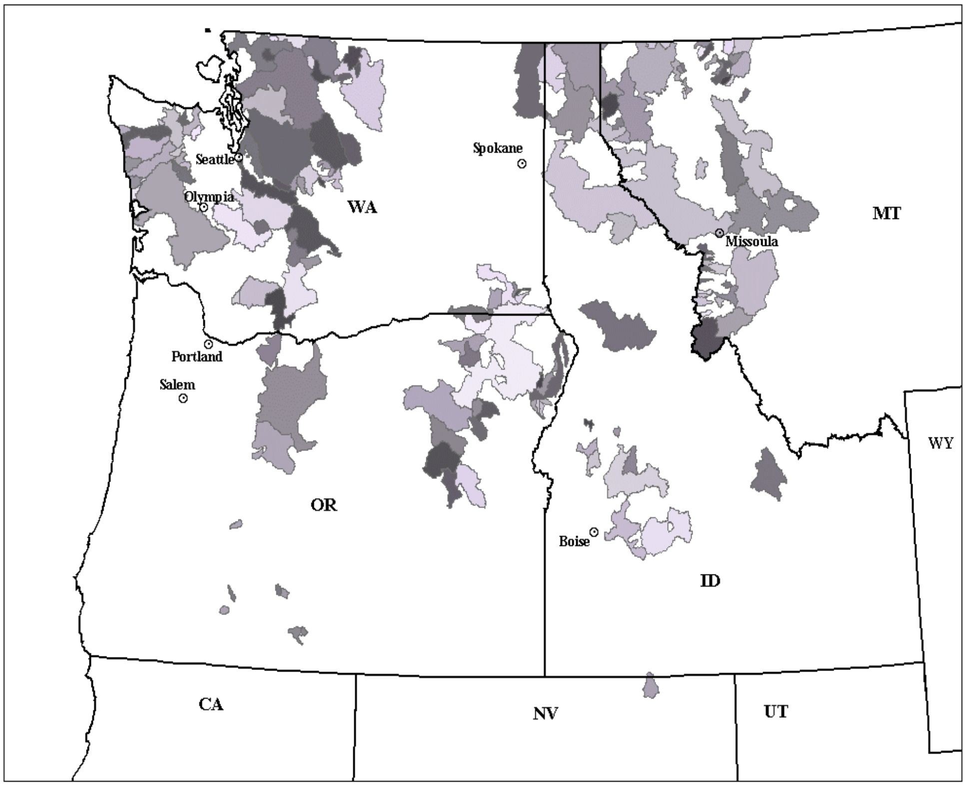


Although bull trout are presently widespread within their historical range in the coterminous United States, they have declined in overall distribution and abundance during the last century. For example, bull trout have been extirpated in the McCloud River basin, California, as well as locally in tributaries of other river basins. Declines resulted largely from habitat degradation and fragmentation, blockage of migratory corridors, poor water quality, past fisheries management practices, and the introduction of nonnative species. These factors resulted in the reduction or elimination of migratory bull trout. Retaining migratory forms of bull trout in a population is important because these forms allow fish access to more resources (*i.e.*, food and habitat), opportunities for genetic exchange, and the ability to recolonize habitats after local extirpations (*e.g.*, by a watershed-wide disturbance affecting all bull trout in a resident population).

On June 10, 1998, the U.S. Fish and Wildlife Service issued a final rule listing the Columbia River and Klamath River populations of bull trout as threatened (63 FR 31647) under the authority of the Endangered Species Act of 1973. This decision conferred full protection of the Endangered Species Act on bull trout occurring in four northwestern States. The Jarbidge River population was listed as threatened on April 8, 1999 (64 FR 17110). The Coastal-Puget Sound and St. Mary-Belly River populations were listed as threatened on November 1, 1999 (64 FR 58910), which resulted in all bull trout in the coterminous United States being listed as threatened. The five populations discussed above are listed as distinct population segments, *i.e.*, they meet the joint policy of the U.S. Fish and Wildlife Service and National Marine Fisheries Service regarding the recognition of distinct vertebrate populations (61 FR 4722). We do not consider recovery of bull trout in the McCloud River basin in this recovery plan.

In the rules listing bull trout as threatened, the U.S. Fish and Wildlife Service identified subpopulations (*i.e.*, isolated groups of bull trout thought to lack two-way exchange of individuals), for which status, distribution, and threats to bull trout were evaluated. Because habitat fragmentation and barriers have isolated bull trout throughout their current range, a subpopulation was considered a reproductively isolated group of bull trout that spawns within a particular river or area of a river system. Overall, we identified 187 subpopulations in the 5 distinct population segments, 7 in the Klamath River, 141 in the Columbia River, 1 in the Jarbidge River, 34 in the Coastal-Puget Sound, and 4 in the St. Mary-Belly River populations. Although subpopulations were an appropriate unit on which to conduct evaluations for listing purposes, alternative population units have been defined for recovery planning (see the Strategy for Recovery section for further detail). Therefore, subpopulations are not used in this draft recovery plan. The distribution of bull trout subpopulations identified by the U.S. Fish and Wildlife Service at the times of listing is shown in Figure 3.

Figure 3. Bull trout sub populations.



General Description and Life History

Bull trout have been defined as a distinct species (Cavender 1978), however, the genetic relationship among various groups of bull trout within the species can be complex (Rieman and Allendorf 2001). Biologists had previously confused bull trout with Dolly Varden (*Salvelinus malma*), largely because of the external similarity of appearance and the previous unavailability of adequate specimens of both species to any one taxonomist. Morphological (form and structure) analyses have confirmed the distinctiveness of the two species in their different, but overlapping, geographic distributions (Haas and McPhail 1991). Several genetic studies have subsequently confirmed the species distinction of bull trout and Dolly Varden (Phillips et al. 1989; Crane *et al.* 1994). Both species occur together in western Washington, for example, with little or no interbreeding (Leary and Allendorf 1997). Lastly, bull trout and Dolly Varden each appear to be more closely related genetically to other species of *Salvelinus* than they are to each other (Phillips *et al.* 1989; Greene *et al.* 1990; Phillips *et al.* 1991; Pleyte *et al.* 1992). For example, bull trout are most closely related to Japanese char (*S. leucomaenis*) whereas Dolly Varden are most closely related to Arctic char (*S. alpinus*).

With genetic theory, bull trout can be grouped into population units that share an evolutionary legacy, termed metapopulations and local populations (Kanda and Allendorf 2001). Metapopulations are composed of one or more local populations. For this recovery plan, bull trout have been grouped into distinct population segments, recovery units, core areas and local populations. Core areas are composed of one or more local populations, recovery units are composed of one or more core areas, and a distinct population segment is composed of one or more recovery units. The manner in which bull trout were grouped in the recovery plan represents an adaptive comparison of genetic population structure and management considerations. (See Strategy for Recovery section for additional discussion of recovery units, core areas, local populations and genetic structure of bull trout.)

Bull trout exhibit both resident and migratory life-history strategies (Rieman and McIntyre 1993). Resident bull trout complete their entire life cycle in the tributary (or nearby) streams in which they spawn and rear. Migratory bull trout spawn in tributary streams where juvenile fish rear one to four years before migrating to either a lake (adfluvial form), river (fluvial form) (Fraley and Shepard 1989; Goetz 1989), or in certain coastal areas, to saltwater (anadromous) (Cavender 1978; McPhail and Baxter 1996; Washington Department of Fish and Wildlife. *et al.* 1997). Resident and migratory forms may be found together, and either form may give rise to offspring exhibiting either resident or migratory behavior (Rieman and McIntyre 1993).

The size and age of bull trout at maturity depends upon life-history strategy. Resident fish tend to be smaller than migratory fish at maturity and produce fewer eggs (Fraley and Shepard 1989; Goetz 1989). Bull trout normally reach sexual maturity in 4 to 7 years and may live longer than 12 years. Repeat- and alternate-year spawning has been reported, although repeat-spawning frequency and post-spawning mortality are not well documented (Leathe and Graham 1982; Fraley and Shepard 1989; Pratt 1992; Rieman and McIntyre 1996).

Essential Habitat Characteristics

Bull trout have more specific habitat requirements than most other salmonids (Rieman and McIntyre 1993). Habitat components that influence bull trout distribution and abundance include water temperature, cover, channel form and stability, valley form, spawning and rearing substrate, and migratory corridors (Fraley and Shepard 1989; Goetz 1989; Hoelscher and Bjornn 1989; Sedell and Everest 1991; Howell and Buchanan 1992; Pratt 1992; Rieman and McIntyre 1993, 1995; Rich 1996; Watson and Hillman 1997). Watson and Hillman (1997) concluded that watersheds must have specific physical characteristics to provide the habitat requirements necessary for bull trout to successfully spawn and rear and that these specific characteristics are not necessarily present throughout these watersheds. Because bull trout exhibit a patchy distribution, even in pristine habitats (Rieman and McIntyre 1993), fish should not be expected to simultaneously occupy all available habitats (Rieman et al.1997b1).

Migratory corridors link seasonal habitats for all bull trout life histories. For example, in Montana, migratory bull trout make extensive migrations in the Flathead River system (Fraley and Shepard 1989), and resident bull trout in tributaries of the Bitterroot River move downstream to overwinter in tributary pools (Jakober 1995). The ability to migrate is important to the persistence of bull trout (Rieman and McIntyre 1993; M. Gilpin, *in litt.* 1997; Rieman et al. 1997) (see also The Role of the Mainstem Columbia and Snake Rivers discussion). Migrations facilitate gene flow among local populations when individuals from different local populations interbreed, or stray, to nonnatal streams. Local populations that are extirpated by catastrophic events may also become reestablished by bull trout migrants.

Bull trout are found primarily in the cold streams, although individual fish are found in larger, warmer river systems throughout the Columbia River basin (Fraley and Shepard 1989; Rieman and McIntyre 1993, 1995; Buchanan and Gregory 1997; Rieman et al. 1997). Water temperature above 15 degrees Celsius (59 degrees Fahrenheit) is believed to limit bull trout distribution, a limitation that may partially explain the patchy distribution within a watershed (Fraley and Shepard 1989; Rieman and McIntyre 1995). Spawning areas are often associated with cold-water springs, groundwater infiltration, and the coldest streams in a given watershed (Pratt 1992; Rieman and McIntyre 1993; Rieman et al. 1997; Baxter *et al.* 1999). Goetz (1989) suggested optimum water temperatures for rearing of about 7 to 8 degrees Celsius (44 to 46 degrees Fahrenheit) and optimum water temperatures for egg incubation of 2 to 4 degrees Celsius (35 to 39 degrees Fahrenheit). For Granite Creek, Idaho, Bonneau and Scarnecchia (1996) observed that juvenile bull trout selected the coldest water available in a plunge pool, 8 to 9 degrees Celsius (46 to 48 degrees Fahrenheit), within a temperature gradient of 8 to 15 degrees Celsius (46 to 60 degrees Fahrenheit). In Nevada, adult bull trout have been collected at 17.2 degrees Celsius (63 degrees Fahrenheit) in the West Fork of the Jarbidge River (S. Werdon, pers. comm. 1998) and have been observed in Dave Creek where maximum daily water temperatures were 17.1 to 17.5 degrees Celsius (62.8 to 63.6 degrees Fahrenheit) (Werdon, *in litt.* 2001). In the Little Lost River, Idaho, bull trout have been collected in water having temperatures up to 20 degrees Celsius (68 degrees Fahrenheit); however, these fish made up less than 50 percent of all salmonids when maximum summer water temperature exceeded 15 degrees Celsius (59 degrees Fahrenheit) and less than 10 percent of all salmonids when temperature exceeded 17 degrees Celsius (63 degrees Fahrenheit) (Gamett 1999).

All life-history stages of bull trout are associated with complex forms of cover, including large woody debris, undercut banks, boulders, and pools (Fraley and Shepard 1989; Goetz 1989; Hoelscher and Bjornn 1989; Sedell and Everest 1991; Pratt 1992; Thomas 1992; Rich 1996; Sexauer and James 1997; Watson and Hillman 1997). Jakober (1995) observed bull trout overwintering in deep beaver ponds or pools containing large woody debris in the Bitterroot River drainage, Montana, and suggested that suitable winter habitat may be more restricted than summer habitat. Maintaining bull trout habitat requires stability of stream channels and of flow stability (Rieman and McIntyre 1993). Juvenile and adult bull trout frequently inhabit side channels, stream margins, and pools with suitable cover (Sexauer and James 1997). These areas are sensitive to activities that directly or indirectly affect stream channel stability and alter natural flow patterns. For example, altered stream flow in the fall may disrupt bull trout during the spawning period, and channel instability may decrease survival of eggs and young juveniles in the gravel from winter through spring (Fraley and Shepard 1989; Pratt 1992; Pratt and Huston 1993).

Preferred spawning habitat consists of low-gradient stream reaches with loose, clean gravel (Fraley and Shepard 1989) and water temperatures of 5 to 9 degrees Celsius (41 to 48 degrees Fahrenheit) in late summer to early fall (Goetz 1989). In the Swan River, Montana, abundance of bull trout redds (spawning areas) was positively correlated with the extent of bounded alluvial valley reaches, which are likely areas of groundwater to surface water exchange (Baxter *et al.* 1999). Survival of bull trout embryos planted in stream areas of groundwater upwelling used by bull trout for spawning were significantly higher than embryos planted in areas of surface-water recharge not used by bull trout for spawning (Baxter and McPhail 1999). Pratt (1992) indicated that increases in fine sediment reduce egg survival and emergence.

Bull trout typically spawn from August to November during periods of decreasing water temperatures. Water temperatures during spawning generally range from 4 to 10 degrees Celsius (39 to 51 degrees Fahrenheit). Redds are often constructed in stream reaches fed by springs or near other sources of cold groundwater (Goetz 1989; Pratt 1992; Rieman and McIntyre 1996). Migratory bull trout frequently begin spawning migrations as early as April and have been known to move upstream as far as 250 kilometers (155 miles) to spawning grounds in Montana (Fraley and Shepard 1989; Swanberg 1997). In Idaho, bull trout moved 109 kilometers (67.5 miles) from Arrowrock Reservoir to spawning areas in the headwaters of the Boise River (Flatter 1998). In the Blackfoot River, Montana, bull trout began spring migrations to spawning areas in response to increasing temperatures (Swanberg 1997). Depending on water temperature, incubation is normally 100 to 145 days (Pratt 1992), and after hatching, juveniles remain in the substrate. Time from egg deposition to emergence of fry may surpass 200 days. Fry normally emerge from early April through May, depending on water temperatures and increasing stream flows (Pratt 1992; Ratliff and Howell 1992).

Growth varies depending upon life-history strategy. Resident adults range from 150 to 300 millimeters (6 to 12 inches) total length, and migratory adults commonly reach 600 millimeters (24 inches) or more (Pratt 1985; Goetz 1989). The largest verified bull trout is a 14.6-kilogram (32-pound) specimen caught in Lake Pend Oreille, Idaho, in 1949 (Simpson and Wallace 1982).

Bull trout are opportunistic feeders, with food habits primarily a function of size and life-history strategy. Resident and juvenile migratory bull trout prey on terrestrial and aquatic insects, macro-zooplankton, and small fish (Boag 1987; Goetz 1989; Donald and Alger 1993). Adult migratory bull trout feed on various fish species (Leathe and Graham 1982; Fraley and Shepard 1989; Brown 1992; Donald and Alger 1993). In coastal areas of western Washington, bull trout feed on Pacific herring (*Clupea pallasi*), Pacific sand lance (*Ammodytes hexapterus*), and surf smelt (*Hypomesus pretiosus*) in the ocean (WDFW *et al.* 1997).

Aquatic Community

In the Columbia River and Klamath River basins, bull trout occur with native cutthroat trout (*Oncorhynchus clarki* subspecies), resident (redband) and migratory (steelhead) rainbow trout (*O. mykiss*), chinook salmon (*O. tshawytscha*), sockeye salmon (*O. nerka*), mountain whitefish (*Prosopium williamsoni*), and various sculpin (Cottidae), sucker (Catostomidae), and minnow (Cyprinidae) species (Mauser *et al.* 1988; WDF *et al.* 1993; WDFW 1998). In the Jarbidge River basin, bull trout occur with native redband trout, mountain whitefish, sculpin, bridgelip sucker (*Catostomus columbianus*), and various minnow species (Warren and Partridge 1993; Johnson and Weller 1994; Zoellick *et al.* 1996; Partridge and Warren 1998; Johnson 1999). In the Coastal-Puget Sound areas, bull trout occur with native cutthroat trout, steelhead, chinook salmon, coho salmon (*O. kisutch*), pink salmon (*O. gorbuscha*), chum salmon (*O. keta*), sockeye salmon, mountain whitefish, pygmy whitefish (*P. coulteri*), and various sculpin, sucker, and minnow species (R2 Resource Consultants, Inc. 1993; WDF *et al.* 1993; WDFW 1998). In the St. Mary-Belly River system, bull trout occur with native westslope cutthroat trout, lake trout (*S. namaycush*), mountain whitefish, northern pike (*Esox lucius*), trout-perch (*Percopsis omiscomaycus*), and various sculpin, sucker, and minnow species (Fredenberg 1996; Holton and Johnson 1996).

Bull trout habitat within the coterminous United States often overlaps with the range of several fishes listed as threatened, endangered, or proposed for listing under the Endangered Species Act, including endangered Snake River sockeye salmon (56 FR 58619), threatened Snake River spring/summer and fall chinook salmon (57 FR

14653), endangered Kootenai River white sturgeon (*Acipenser transmontanus*) (59 FR 45989), threatened and endangered steelhead (62 FR 43937), threatened Puget Sound chinook salmon (63 FR 11481), and threatened Hood Canal summer-run chum salmon and Columbia River chum salmon (64 FR 14507).

Nonnative salmonids (members of the trout and salmon family) have been widely introduced and have become established in numerous areas throughout the range of bull trout. These species include brook trout (*S. fontinalis*), lake trout (west of the Continental Divide, *i.e.*, excluding the St. Mary-Belly River system where they are native), brown trout (*Salmo trutta*), Arctic grayling (*Thymallus arcticus*), and lake whitefish (*Coregonus clupeaformis*). Kokanee (a freshwater form of *O. nerka*), nonnative strains of rainbow trout, and nonnative subspecies of cutthroat trout have also been introduced into areas where they did not occur naturally.

Reasons for Decline

Bull trout distribution, abundance, and habitat quality have declined rangewide (Bond 1992; Schill 1992; Thomas 1992; Ziller 1992; Rieman and McIntyre 1993; Newton and Pribyl 1994; Idaho Department of Fish and Game, *in litt.* 1995; McPhail and Baxter 1996). Several local extirpations have been documented, beginning in the 1950's (Rode 1990; Ratliff and Howell 1992; Donald and Alger 1993; Goetz 1994; Newton and Pribyl 1994; Berg and Priest 1995; Light *et al.* 1996; Buchanan *et al.* 1997; WDFW 1998). Bull trout were extirpated from the southernmost portion of their historic range, the McCloud River in California, around 1975 (Moyle 1976; Rode 1990). Bull trout have been functionally extirpated (*i.e.*, few individuals may occur there but do not constitute a viable population) in the Coeur d'Alene River basin in Idaho and in the Lake Chelan and Okanogan River basins in Washington (USFWS 1998a).

These declines result from the combined effects of habitat degradation and fragmentation, the blockage of migratory corridors; poor water quality, angler harvest and poaching, entrainment (process by which aquatic organisms are pulled through a diversion or other device) into diversion channels and dams, and introduced nonnative species. Specific land and water management activities that depress bull trout populations and degrade habitat include dams and other diversion structures, forest management practices, livestock grazing, agriculture, agricultural diversions, road construction and maintenance, mining, and urban and rural development (Beschta *et al.* 1987; Chamberlin *et al.* 1991; Furniss *et al.* 1991; Meehan 1991; Nehlsen *et al.* 1991; Sedell and Everest 1991; Craig and Wissmar 1993; Frissell 1993; Henjum *et al.* 1994; McIntosh *et al.* 1994; Wissmar *et al.* 1994; USDA and USDI 1995, 1996, 1997; Light *et al.* 1996; MBTSG 1995a-e, 1996a-f).

Threats to bull trout in the coterminous United States fall into several categories including habitat isolation, loss or blockage of migratory corridors, poor water quality, and the introduction of nonnative species (63 FR 31647, 64 FR 17110, 64 FR 58910). The Jarbidge River population segment is additionally threatened by habitat degradation from past and ongoing land management activities such as road construction and maintenance, mining, and grazing; other activities such as recreational fishing (intentional and unintentional harvest); and interactions with stocked rainbow trout (64 FR 17110). Threats to the St. Mary-Belly River population also include irrigation dams, unscreened diversions, and interactions with nonnative brook trout (64 FR 58910). Additional threats to bull trout are the continuing effects of activities conducted in the past, activities that have been discontinued or modified in recent years to lessen negative effects.

Dams

Dams affect bull trout by altering habitats; flow, sediment, and temperature regimes; migration corridors; and creating additional interspecific interactions, mainly between bull trout and nonnative species (Rode 1990; WDW 1992; Craig and Wissmar 1993; Rieman and McIntyre 1993; Wissmar *et al.* 1994; T. Bodurtha, U.S. Fish and Wildlife Service, *in litt.* 1995; USDA and USDI 1996, 1997). Impassable dams have caused declines of bull trout by preventing migratory fish from reaching spawning and rearing areas in headwaters and recolonizing areas where bull trout have been extirpated (Rieman and McIntyre 1993; MBTSG 1998).

The extirpation of bull trout in the McCloud River basin, California, has been attributed primarily to construction and operation of McCloud Dam, which began operation in 1965 (Rode 1990). McCloud Dam flooded bull trout spawning, rearing, and migratory habitats. The dam also resulted in elevated water temperatures.

Although dams negatively affect bull trout (Rieman and McIntyre 1993; Gilpin, *in litt.* 1997), some dams can benefit bull trout by blocking introduced nonnative species from upstream areas (MBTSG 1995e). Some dams also increase the potential forage base for bull trout by creating reservoirs that support prey species (Faler and Bair 1991; Pratt 1992).

Some of the major effects to bull trout resulting from the Federal Columbia River Power System and from operation of other hydropower, flood control, and irrigation diversion facilities (see also Agricultural Practices) include the following: (1) fish passage barriers, (2) entrainment of fish into turbine intakes and irrigation canals, (3) inundation of fish spawning and rearing habitat, (4) modification of stream flows and water temperature regimes, (5) dewatering of shallow water zones during power peaking operations, (6) reduced productivity in reservoirs, (7) periodic gas supersaturation of waters downstream of dams, (8) water level fluctuations interfering with retention of riparian vegetation along reaches affected by power peaking operations, (9) establishment of nonnative riparian vegetation along reaches affected by power peaking operations, and (10) severe reductions in reservoir levels to accommodate flood control operations.

Hungry Horse, Libby, Albeni Falls, Dworshak, Chief Joseph, Keechelus, Tieton, and Grand Coulee dams, as well as others in the Columbia River basin and throughout the range of bull trout in the coterminous United States, were built without fish passage facilities and are barriers to bull trout migration. These barriers have contributed to the isolation of local populations of migratory bull trout. The lower Snake, middle Columbia, and lower Columbia River hydropower projects have both adult and juvenile fish passage facilities, but these fishways were designed specifically for anadromous salmonids, not for resident fish such as bull trout. The designs, therefore, address the migration needs of anadromous, primarily semelparous (*i.e.*, fish that spawn only once in a lifetime) of the genus *Oncorhynchus* (except steelhead, which in some instances can spawn more than once in a lifetime), but do not include consideration for iteroparous fish (*i.e.*, those that can spawn more than once), or fish that merely wander both upstream and downstream as adults to forage. Bull trout have been observed using upstream fish passage facilities at many of the hydropower projects on the Snake and Columbia rivers. However, as indicated above, even dams with fish passage facilities may be a factor in isolating bull trout local populations if they are not readily passable by bull trout and/or if the dams do not provide an adult downstream migration route.

Entrainment of bull trout may also occur at various projects in the Columbia River basin including Libby, Hungry Horse, Albeni Falls, Rocky Reach, Rock Island, Wells, Dworshak, Bonneville, Ice Harbor, Lower Monumental, Little Goose, and Lower Granite dams. Fish can be killed or injured when passing the dams. Potential passage routes include through spill, the turbines, or the juvenile bypass systems, but the relative passage success of these routes for adult salmonids has not been thoroughly investigated. However, one study conducted in the early 1970's revealed that passage through turbines resulted in a 22 to 41 percent mortality rate for adult steelhead (Wagner and Ingram 1973). Additionally, a 40 to 50 percent injury rate for adult salmonids passing through the juvenile fish bypass system at McNary Dam has been noted (Wagner 1991; Wagner and Hilson 1993). Adult bull trout may experience similar mortality rates. In addition, those adult fish that survive passage at projects that do no have upstream passage facilities are isolated in downstream reaches away from their natal (native) streams. As indicated above, the loss of these larger, more fecund migratory fish is detrimental to their natal populations.

The creation of mainstem Columbia and Snake river pools (*i.e.*, the areas of slow moving water behind the dams) combined with introductions of piscivorous species (*e.g.*, bass, walleye) have also affected the habitat of bull trout and other salmonids. An increase in predator populations, both native (*e.g.*, northern pikeminnow) and nonnative, as a result of creating artificial habitat and concentrating prey is discussed as a factor for the decline of each listed Snake River salmon species (NMFS 1991a, b, and c). Ideal predator foraging environments have been created in these pools, particularly for warm water species in the summer. Smolts that pass through the projects are subjected to turbines, bypasses, and spillways, that may result in disorientation and increased stress, conditions that reduce their ability to avoid predators below the dams. Creation of the pools above the dams has resulted in low water velocities that increase smolt travel time and increase predation opportunity. Increased water temperatures, also a result of the impoundment of the river, have also been shown to increase predation rates on salmonid smolts (Vigg and Burley 1991). Because bull trout are apex (top) predators of other fish, negative effects to the salmonid smolt prey base, and the resulting decline in adult returns, are likely to affect bull trout negatively as well. Additionally, increased water temperatures, influenced by the presence of dams, also decreases the suitability of the lower Snake and Columbia river pools for bull trout in the late spring through early fall.

Uncontrolled spill, or even high levels of managed spill, at hydropower projects can produce extremely high levels of total dissolved gas that may impact bull trout and other species. These high levels of gas supersaturation can cause gas bubble disease trauma in fish. Gas bubble disease is caused by gas being absorbed into the bloodstream of fish during respiration. Effects can range from temporary debilitation to mortality, and supersaturation can persist for several miles below dams where spill occurs. The states of Oregon and Washington have established a 111 percent total dissolved gas level as State water quality standards. However, total dissolved gas levels of up to 120 percent have been experienced during recent years of managed spill in the Federal Columbia River Power System, with involuntary spill episodes resulting in total dissolved gas levels of as high as 140 percent at some sites (NMFS 2000). At levels near 140 percent, gas bubble disease may occur in over 3 percent of fish exposed. At levels of up to 120 percent the incidence of gas bubble disease decreases to a maximum of 0.7 percent of fish exposed (NMFS 2000).

Manipulated flow releases from storage projects alter the natural flow regime, affect water temperature, have the potential to destabilize downstream streambanks, alter the natural sediment and nutrient loads, and cause repeated and prolonged changes to the downstream wetted perimeter (MBTSG 1998). Power peaking operations, which change the downstream flow of the river on a frequent basis, cause large areas of the river margins to become alternately wet and then dry, adversely affecting aquatic insect survival and production (Hauer and Stanford 1997). Changes in water depth and velocity as a result of rapid flow fluctuations, and physical loss or gain of wetted habitat, can cause juvenile trout to be displaced, thus increasing their vulnerability to predation. Additionally, rapid flow reductions can strand young fish if they are unable to escape over and through draining or dewatered substrate. These effects also indirectly adversely affect bull trout by degrading the habitat of their prey (small fish) and the food upon which they depend (aquatic insects).

Reservoirs created by dams have also inundated bull trout habitat. For example, reservoirs created by the construction of Libby and Hungry Horse dams have inundated miles of mainstem river and tributary habitat previously used by many local populations of bull trout (BPA *et al.* 1999). Reservoir water level manipulations can create migration barriers at the confluence of tributaries entering the reservoir, as well as negatively affecting littoral rearing habitats for prey species of bull trout. Reservoir levels are often drawn down substantially during drought years, or annually as operators evacuate flood control reservoirs to make room for spring snowmelt runoff. Reduced volumes of water in reservoirs can affect their overall productivity, that may ultimately reduce the food base of predators such as bull trout. Some reservoir levels have periodically been reduced so severely that bull trout and other species have had to be physically removed and relocated to ensure their survival. Other reservoirs are unproductive and provide poor habitat for bull trout compared to natural riverine habitats (*e.g.*, Noxon and Cabinet Gorge). However, reservoirs such as Libby, Hungry Horse, and Dworshak now provide suitable habitat for adfluvial populations of bull trout that was not available prior to dam construction.

Forest Management Practices

Forest management activities, including timber extraction and road construction, affect stream habitats by altering recruitment of large woody debris, erosion and sedimentation rates, runoff patterns, the magnitude of peak and low flows, water temperature, and annual water yield (Cacek 1989; Furniss *et al.* 1991; Wissmar *et al.* 1994; Spence *et al.* 1996; Spencer and Schelske 1998; Swanson *et al.* 1998). Activities that promote excessive substrate movement reduce bull trout production by increasing egg and juvenile mortality, and reducing or eliminating habitat (*e.g.*, pools filled with substrate) important to later life-history stages (Fraley and Shepard 1989; Brown 1992). The length and timing of bull trout egg incubation and juvenile development (typically more than 200 days during winter and spring) and the strong association of juvenile fish with stream substrate make bull trout vulnerable to changes in peak flows and timing that affect channels and substrate (Goetz 1989; Pratt 1992; McPhail and Baxter 1996; MBTSG 1998).

Roads constructed for forest management are a prevalent feature on managed forested and rangeland landscapes. Roads have the potential to adversely affect several habitat features, (*e.g.*, water temperature, substrate composition and stability, sediment delivery, habitat complexity, and connectivity) (Baxter *et al.* 1999; Trombulak and Frissell 2000). Roads may also isolate streams from riparian areas, causing a loss in floodplain and riparian function. The aquatic assessment portion of the Interior Columbia Basin Ecosystem Management Project provided a detailed analysis of the relationship between road densities and bull trout status and distribution (Quigley and Arbelbide 1997). The assessment found that bull trout are less likely to use streams in highly roaded areas for spawning and rearing, and do not typically occur where average road densities exceed 1.1 kilometers per square kilometer (1.7 miles per square mile).

Although bull trout occur in watersheds where timber has been harvested, bull trout strongholds primarily occur in watersheds with little or no past timber harvest, such as the wilderness areas of central Idaho and the South Fork Flathead River drainage in Montana (Henjum *et al.* 1994; MBTSG 1995e; USDA and USDI 1997; Rieman et al. 1997b). However, the Swan River basin, Montana, has had extensive timber harvest and road construction, and is a bull trout stronghold (Watson and Hillman 1997). The overall effects of forestry practices on bull trout in parts of this basin are difficult to assess because of the complex geomorphology and geology of the drainage (MBTSG 1996a).

Roads may affect aquatic habitats considerable distances away. For example, increases in sedimentation, debris flows, and peak flows affect streams longitudinally so that the area occupied by a road can be small compared to the entire downstream area subjected to its effects (Jones *et al.* 2000; Trombulak and Frissell 2000). Upstream from road crossings, large areas of suitable habitats may become inaccessible to bull trout due to fish passage barriers (*e.g.*, culverts).

Livestock Grazing

Improperly managed livestock grazing degrades bull trout habitat by removing riparian vegetation, destabilizing streambanks, widening stream channels, promoting incised channels and lowering water tables, reducing pool frequency, increasing soil erosion, and altering water quality (Howell and Buchanan 1992; Mullan *et al.* 1992; Overton *et al.* 1993; Platts *et al.* 1993; Uberuaga 1993; Henjum *et al.* 1994; MBTSG 1995a,b,c; USDA and USDI 1996, 1997). These effects reduce overhead cover, increase summer water temperatures, and promote formation of anchor ice (ice attached to the bottom of an otherwise unfrozen stream, often covering stones, etc.) in winter, and increase sediment in spawning and rearing habitats.

Negative effects of livestock grazing on bull trout habitat may be minimized if grazing is managed appropriately for conditions at a specific site. Practices generally compatible with the preservation and restoration of bull trout habitat include fences to exclude livestock from riparian areas, rotation schemes, relocation of water and salting facilities away from riparian areas, and use of herders.

Agricultural Practices

Agricultural practices, such as cultivation, irrigation diversions, and chemical application, contribute to nonpoint source pollution in some areas within the range of bull trout (IDHW 1991; WDE 1992; MDHES 1994). These practices can release sediment, nutrients, pesticides, and herbicides into streams; increase water temperature; reduce riparian vegetation; and alter hydrologic regimes, typically by reducing flows in spring and summer. Irrigation diversions also affect bull trout by altering stream flow and allowing entrainment. The effects of the myriad of small irrigation diversion and hydropower projects throughout the range of bull trout are likely of even greater significance than the large hydropower and flood control projects. Many of these are located further up in watersheds and either physically block fish passage by means of a structure (*i.e.*, a dam), or effectively block passage by periodically dewatering a downstream reach (*e.g.*, diversion of flows through a penstock to a powerhouse; diversion of flows for the purposes of irrigation). Even if diversions are not so severe as to dewater downstream reaches, reduced flows can result in structural and thermal passage barriers. Other effects include water quality degradation resulting from irrigation return flows and runoff from fields and entrainment of bull trout into canals and fields (MBTSG 1998). Some irrigation diversion structures are reconstituted annually with a bulldozer as “push up” berms and not only affect passage, but also significantly degrade the stream channel. The prevalence of these structures throughout the range of bull trout has resulted in the isolation of bull trout populations in the upper watersheds in many areas.

Bull trout may enter unscreened irrigation diversions and become stranded in ditches and agricultural fields. Diversion dams without proper passage facilities prevent bull trout from migrating and may isolate groups of fish (Dorratcaque 1986; Light *et al.* 1996). Other effects of agricultural practices on aquatic habitat include stream channelization, and large woody debris removal (Spence *et al.* 1996).

Transportation Networks

Roads degrade bull trout habitats by creating flow constraints in ephemeral, intermittent, and perennial channels; increasing erosion and sedimentation; creating passage barriers; channelizing stream reaches; and reducing riparian vegetation (Furniss *et al.* 1991; Ketcheson and Megahan 1996; Trombulak and Frissell 2000). In the Clearwater River basin of Idaho, for example, Highway 12 is adjacent to much of the Clearwater River, and crosses the river at eight different bridge sites. The highway has constrained the river in some areas and highway maintenance may negatively affect bull trout and their habitats (CBBTTAT 1998). Moreover, the proximity of the highway to the Clearwater River increases the likelihood of hazardous materials or fuel spills entering the river. For example, in January, 2002, a truck overturned and spilled approximately 11,000 gallons in the Clearwater River upstream of Lewiston. Similar situations exist along primary and secondary highways across the range of bull trout.

A dirt road is adjacent to much of the West Fork of the Jarbidge River in Nevada and Idaho. McNeill *et al.* (1997) determined that construction and maintenance of the Jarbidge Canyon Road has influenced the morphology and function of the river. Within a single 4.8 kilometer (3 mile) reach, there are seven bridge crossings, and the largest bridge spans only 62 percent of the average width of the river (McNeill *et al.* 1997). Maintenance of the road and bridges requires frequent channel and floodplain modifications that affect bull trout habitat, such as channelization; removal of riparian trees and beaver dams; and placement of rock, sediment, and concrete (McNeill *et al.* 1997; J. Frederick, U.S. Forest Service (USFS), pers. comm. 1998; J. Frederick, U.S. Forest Service, 1998).

Transportation networks also affect bull trout habitats in protected areas such as National Parks. Roads have been constructed to provide access to the Hoh River and Quinault River basins, including areas within Olympic National Park. These roads were typically built following river valleys and often constrain the floodplains. As a result, these roads have been subjected to high flow events and shifts in river channels, forcing extensive streambank armoring to maintain them (Chad 1997; U.S. National Park Service 2000). Bank armoring impairs bull trout habitats through reduced habitat complexity, stream channelization, reduced riparian vegetation, and bank erosion downstream. Within Olympic National Park, about 1,770 meters (5,476 feet) of rip-rap were documented along the Hoh River in 1997 (Chad 1997), and additional bank stabilization projects have occurred since then.

Mining

Mining degrades aquatic habitats used by bull trout by altering water chemistry (*e.g.*, pH); altering stream morphology and flow; and causing sediment, fuel, and heavy metals to enter streams (Martin and Platts 1981; Spence *et al.* 1996). The types of mining that occur within the range of bull trout include extraction of hard rock minerals, coal, gas, oil, and sand and gravel. Past and present mining activities have adversely affected bull trout and bull trout habitats in Idaho, Oregon, Montana, Nevada, and Washington (Johnson and Schmidt 1988; Moore *et al.* 1991; WDW 1992; Platts *et al.* 1993; MBTSG 1995a, c, 1996b, c; McNeill *et al.* 1997; Ramsey 1997).

For example, it is thought that bull trout were widely distributed in the Coeur d'Alene River drainage, Idaho (Maclay 1940). However, extensive mining and associated operations have modified stream channels and floodplains, created barriers to fish movement, and released toxic substances, especially in the South Fork Coeur d'Alene River (PBTTAT 1998). Portions of the system were essentially devoid of aquatic life during surveys conducted in the 1940's. Bull trout have been functionally extirpated in the Coeur d'Alene River basin since 1992 (USFWS 1998a).

Residential Development and Urbanization

Residential development is rapidly increasing within portions of the range of bull trout. Residential development alters stream and riparian habitats through contaminant inputs, stormwater runoff, changes in flow regimes, streambank modification and destabilization, increased nutrient loads, and increased water temperatures (MBTSG 1995b). Indirectly, urbanization within floodplains alters groundwater recharge by rapidly routing water into streams through drains rather than through more gradual subsurface flow (Booth 1991).

Urbanization negatively affects the lower reaches of many of the large rivers and their associated side channels, wetlands, estuaries, and near-shore areas of Puget Sound, Washington. Activities such as dredging; removing large woody debris (*e.g.*, snags, log jams, drift wood); installing revetments, bulkheads, and dikes; and filling side channels, estuarine marshes, and mudflats have led to the reduction, simplification, and degradation of habitats (Thom *et al.* 1994; Spence *et al.* 1996; PSWQAT 2000). Pollutants associated with urban environments such as heavy metals, pesticides, fertilizers, bacteria, and organics (oil, grease) have contributed to the degradation of water quality in streams, lakes, and estuaries (NRC 1996; Spence *et al.* 1996).

Fisheries Management

Introductions of nonnative species by the Federal government, State fish and game departments, and private parties, across the range of bull trout have contributed to declines in abundance, local extirpations, and hybridization of bull trout (Bond 1992; Howell and Buchanan 1992; Leary *et al.* 1993; Donald and Alger 1993; Pratt and Huston 1993; MBTSG 1995b,d, 1996g,h; Platts *et al.* 1995; J. Palmisano and V. Kaczynski, Northwest Forest Resource Council, *in litt.* 1997).

Introduced brook trout threaten bull trout through hybridization, competition, and possibly predation (Thomas 1992; WDW 1992; Clancy 1993; Leary *et al.* 1993; Rieman and McIntyre 1993; MBTSG 1996h). Hybridization between brook trout and bull trout has been reported in Montana (MBTSG 1995a, b, 1996a, c, e; Hansen and DosSantos 1997), Oregon (Markle 1992; Ratliff and Howell 1992), Washington (WDFW 1998), and Idaho (Adams 1996; T. Burton, Boise National Forest, pers. comm. 1997). Hybridization results in offspring that are frequently sterile (Leary *et al.* 1993), although recent genetics work has shown that reproduction by hybrid fish is occurring at a higher level than previously suspected (Kanda 1998). Hybrids may be competitors; Dunsmoor and Bienz (L. Dunsmoor and C. Bienz, Klamath Tribe, *in* *litt.* 1997) noted that hybrids are aggressive and larger than resident bull trout, suggesting that hybrids may have a competitive advantage. Brook trout mature at an earlier age and have a higher reproductive rate than bull trout. This difference may favor brook trout over bull trout when they occur together, often leading to replacement of bull trout with brook trout (Clancy 1993; Leary *et al.* 1993; MBTSG 1995b). The magnitude of threats from nonnative fishes is highest for resident bull trout because they are typically isolated and exist in low abundance.

Brook trout apparently adapt better to degraded habitats than bull trout (Clancy 1993; Rich 1996; Dunsmoor and Bienz, *in litt.* 1997), and brook trout also tend to occur in streams with higher water temperatures (Adams 1994; MBTSG 1996h). Because elevated water temperatures and sediments are often indicative of degraded habitat conditions, bull trout may be subject to stresses from both interactions with brook trout and degraded habitat (MBTSG 1996h). In laboratory tests, growth rates of brook trout were significantly greater than those for bull trout at higher water temperatures when the two species were tested alone, and growth rates of brook trout were greater than those for bull trout at all water temperatures when the species were tested together (McMahon *et al.* 1998, 1999).

Nonnative lake trout (*i.e.*, west of the Continental Divide) also negatively affect bull trout (Donald and Alger 1993; MBTSG 1996h; Fredenberg 2000). A study of 34 lakes in Montana, Alberta, and British Columbia, Canada, found that lake trout likely limit foraging opportunities and reduce the distribution and abundance of migratory bull trout in mountain lakes (Donald and Alger 1993). Over 250 introductions of lake trout and other nonnative species have occurred in nearly 150 western Montana waters within the range of bull trout (J. Vashro, Montana Fish, Wildlife and Parks, *in litt.* 2000). The potential for introduction of lake trout into the Swan River basin and Hungry Horse Reservoir on the South Fork Flathead River, both in Montana, is considered a threat to bull trout (MBTSG 1995e, 1996a). The presence of several lake trout has been recently documented in Swan Lake (Montana Fish, Wildlife and Parks, *in litt.* 1999). In Idaho, lake trout and habitat degradation were factors in the decline of bull trout from Priest Lake (Mauser *et al.* 1988; Pratt and Huston 1993). Lake trout have invaded Upper Priest Lake and are a threat to the bull trout there (Fredericks 1999). Juvenile lake trout are also using some riverine habitats in Montana, possibly competing with bull trout (MBTSG 1996h).

Introduced brown trout are established in several areas within the range of bull trout and likely compete for food and space and prey on bull trout (Ratliff and Howell 1992; Platts *et al.* 1993; Pratt and Huston 1993). In the Klamath River basin for example, brown trout occur with bull trout in three streams and have been observed preying on bull trout in one (Light *et al.* 1996). Brown trout may compete for spawning and rearing areas and superimpose redds on bull trout redds (Pratt and Huston 1993; Light *et al.* 1996; MBTSG 1996h). Elevated water temperatures may favor brown trout over bull trout in competitive interactions (MBTSG 1996h). Brown trout may have been a contributing factor in the decline and eventual extirpation of bull trout in the McCloud River, California, after dam construction altered bull trout habitat (Rode 1990).

Nonnative northern pike have the potential to negatively affect bull trout. Northern pike were introduced into Swan Lake in the 1970's (MFWP 1997), and predation on juvenile bull trout has been documented (MBTSG 1996a) but the bull trout population has not declined. Northern pike were also introduced into Salmon, Inez, Seeley, and Alva lakes in the Clearwater River basin, and a tributary to the Blackfoot River, Montana (MFWP 1997). Northern pike numbers have increased in Salmon Lake and Lake Inez, having a negative effect on bull trout (R. Berg, MFWP, pers. comm. 1997). Northern pike in Seeley Lake and Lake Alva are also expected to increase in numbers (Berg, pers. comm. 1997).

Introduced bass (*Micropterus spp.*) may negatively affect bull trout (MFWP 1997). In the Clark Fork River, Montana, Noxon Rapids Reservoir supports fisheries for both smallmouth bass (*M. dolomieui*) and largemouth bass (*M. salmoides*). Both have been high priority sport fish species in management of Noxon Rapids Reservoir. The Montana fishery management objective for Cabinet Gorge Reservoir, downstream of Noxon Rapids Reservoir, is to enhance bull trout while managing the existing bass fishery (MFWP 1997). However, a 1999 Federal Energy Regulatory Commission settlement with the Avista Corporation for dam relicensing makes recovery of bull trout a management priority (Kleinschmidt Associates and Pratt 1998).

Managers are now attempting to balance these potentially conflicting objectives. In the North Fork Skokomish River, Washington, Cushman Reservoir supports largemouth bass, that may prey on juvenile bull trout rearing in the reservoir and lower river above the reservoir (WDFW 1998).

Opossum shrimp (*Mysis relicta*), a crustacean native to the Canadian Shield area, was widely introduced in the 1970's as supplemental forage for kokanee and other salmonids in several lakes and reservoirs across the northwest (Nesler and Bergersen 1991). The introduction of opossum shrimp in Flathead Lake changed the lake's trophic dynamics resulting in expanding lake trout populations and causing increased competition and predation on bull trout (T. Weaver, Montana Fish, Wildlife and Parks, *in litt.* 1993; MBTSG 1995d). Conversely, in Swan Lake, Montana, introduced opossum shrimp and kokanee increased the availability of forage for bull trout, contributing to the significant increase in bull trout numbers in the Swan River basin (MBTSG 1996a).

Nonnative fish threaten bull trout in relatively secure, unaltered habitats, including roadless areas, wildernesses, and national parks. For instance, brook trout occur in tributaries of the Middle Fork Salmon River within the Frank Church-River of No Return Wilderness, including Elk, Camas, Loon, and Big creeks (Thurow 1985) and Sun Creek in Crater Lake National Park (Light *et al.* 1996). Glacier National Park has self-sustaining populations of introduced nonnative species, including lake trout, brook trout, rainbow trout, Yellowstone cutthroat trout, lake whitefish, and northern pike (MBTSG 1995d). Although stocking in Glacier National Park was terminated in 1971, only a few headwater lakes contain exclusively native species, including bull trout. The introduction and expansion of lake trout into the relatively pristine habitats of Kintla Lake, Bowman Lake, Logging Lake, and Lake McDonald in Glacier National Park has nearly extirpated the bull trout due to predation and competition (L. Marnell, National Park Service, *in litt.* 1995; MBTSG 1995d; Fredenberg 2000).

Some introduced species, such as rainbow trout and kokanee, may benefit large adult bull trout by providing supplemental forage (Faler and Bair 1991; Pratt 1992; Vidergar 2000). However, introductions of nonnative game fish can be detrimental due to increased angling and subsequent incidental catch and harvest of bull trout (Rode 1990; Bond 1992; WDW 1992; MBTSG 1995d).

Isolation and Habitat Fragmentation

Although bull trout are widely distributed over a large geographic area, the effects of human activities over the past century have reduced their overall distribution and abundance. Increased habitat fragmentation reduces the amount of available habitat and increases isolation from other populations of the same species (Saunders *et al.* 1991). Burkey (1989) concluded that when species are isolated by fragmented habitats, low rates of population growth are typical in local populations and their probability of extinction is directly related to the degree of isolation and fragmentation. Without sufficient immigration, growth for local populations may be low and probability of extinction high (Burkey 1989, 1995).

Metapopulation concepts of conservation biology theory have been applied to the distribution and characteristics of bull trout (Rieman and McIntyre 1993; Dunham and Rieman 1999). A metapopulation is an interacting network of local populations with varying frequencies of migration and gene flow among them (Meffe and Carroll 1994). Local populations may be extirpated, but can be reestablished by individuals from other local populations. Thus, multiple local populations distributed throughout a watershed provide a mechanism for spreading risk because the simultaneous loss of all local populations is unlikely. Habitat alteration, primarily through the construction of impoundments, dams, and water diversions, has fragmented habitats, eliminated migratory corridors, and isolated bull trout in the headwaters of tributaries

(Rieman et al. 1997b; Dunham and Rieman 1999; Spruell *et al.* 1999; Rieman and Dunham 2000). Based on population genetics, there is more divergence among bull trout than among salmon (Leary and Allendorf 1997), indicating less genetic exchange among bull trout populations. The recolonization rate for bull trout is very low and recolonization may require a very long time, especially in light of the man-made isolation of various bull trout populations.

Migratory corridors allow individuals access to unoccupied but suitable habitats, foraging areas, and refuges from disturbances (Saunders *et al.* 1991). Maintenance of migratory corridors for bull trout is essential to provide connectivity among local populations, and enables the reestablishment of extinct populations. Where migratory bull trout are not present, isolated populations cannot be replenished when a disturbance makes local habitats unsuitable (Rieman and McIntyre 1993; USDA and USDI 1997). Moreover, limited downstream movement was observed for resident bull trout in the Bitterroot River basin (Nelson 1999; Nelson *et al.* in review) suggesting that reestablishment of migratory fish and potential refounding of extinct bull trout populations may be a slow process, if it occurs at all.

Because isolation and habitat fragmentation resulting from migratory barriers have negatively affected bull trout by: (1) reducing geographical distribution; (2) increasing the probability of losing individual local populations (Rieman and McIntyre 1993); (3) increasing the probability of hybridization with introduced brook trout (Rieman and McIntyre 1993); (4) reducing the potential for movements in response to developmental, foraging, and seasonal habitat requirements (MBTSG 1998); and (5) reducing reproductive capability by eliminating the larger, more fecund migratory form from many subpopulations (MBTSG 1998; Rieman and McIntyre 1993), restoring connectivity and restoring the frequency of occurrence of the migratory form will be an important factor in providing for the recovery of bull trout. The manner and degree to which individual dams and diversions affect specific bull trout local populations is likely to vary depending on the specific physical factors at play and the demographic attributes of the local population in question. The individual recovery unit chapters specifically address dam and diversion issues affecting their respective local populations.

Evidence suggests that landscape disturbances, such as floods and fires, have increased in frequency and magnitude within the range of bull trout (Henjum *et al.* 1994; USDA and USDI 1997). Passage barriers and unsuitable habitat that prevent recolonization, have resulted in bull trout extirpation through these landscape disturbances (USDA and USDI 1997). Also, isolated populations are typically small, and more likely to be extirpated by local events than larger populations (Rieman and McIntyre 1995), and can exhibit negative genetic effects.

Land management activities have also altered the frequency and duration of floods or high flows (USDA and USDI 1997). Roads and clear cutting of forested areas tend to magnify the effects of floods, leading to higher flows, erosion, and bedload that scour channels McIntosh *et al.* 1994; USDA and USDI 1997; Spencer and Schelske 1998; Swanson *et al.* 1998), and degrade bull trout habitat (Henjum *et al.* 1994). Erosion from road landslides increases bedload to stream flows (Furniss *et al.* 1991). Increased bedload increases the scouring effect of high stream flows, increasing channel instability and loss of habitat diversity, especially pools (Henjum *et al.* 1994; McIntosh *et al.* 1994). Bull trout eggs and fry in the gravels during scouring likely survive at low rates (Henjum *et al.* 1994). For instance, hundreds of landslides associated with roads on the Clearwater National Forest and Panhandle National Forests resulted from high water in 1995 (R. Patten and J. Penzkover, Panhandle National Forest, *in litt.* 1996), likely reducing survival of bull trout eggs and fry. Habitat degradation has also reduced the number and size of bull trout spawning areas (USDA and USDI 1997).

Inadequacy of Existing Water Quality Standards

Temperature regime is one of the most important water quality factors affecting bull trout distribution (Rieman and McIntyre 1995; Adams and Bjornn 1997). Given the temperature requirements of bull trout (Buchanan and Gregory 1997), existing water quality criteria developed by the States under sections 303 and 304 of the Clean Water Act may not adequately support spawning, incubation, rearing, migration, or combinations of these life-history stages (see Montana 1996; Oregon 1996; 62 FR 41162; Washington 1997; NDEP, *in litt.* 1998; Hicks 2000).

The U.S. Environmental Protection Agency is working with the U.S. Fish and Wildlife Service, National Marine Fisheries Service, State environmental quality agencies, and tribes in Oregon, Idaho, and Washington to develop regional temperature guidance. The goals for this project are to develop U.S. Environmental Protection Agency regional temperature criteria guidance that: (1) meet the biological requirements of native salmonid species for survival and recovery pursuant to the Endangered Species Act, provide for the restoration and maintenance of surface water temperature to support and protect native salmonids pursuant to the Clean Water Act, and meet the Federal trust responsibilities with treaty tribes for rebuilding salmon stocks, (2) recognize the natural temperature potential and limitations of water bodies, and (3) can be effectively incorporated by states and Tribes in programs concerned with water quality standards. States and Tribes will use the new criteria guidance to revise their temperature standards, and if necessary, the U.S.

Environmental Protection Agency and other agencies will use the new criteria guidance to evaluate State and Tribal standard revisions.

The Environmental Protection Agency is currently engaged in formal consultation with the U.S. Fish and Wildlife Service and National Marine Fisheries Service regarding their approval of numeric water quality criteria for (nonconventional) toxic pollutants in the State of Idaho. Consultation on conventional pollutants (pH, dissolved oxygen, temperature) for the State of Oregon was completed in July 1999. We anticipate formal consultation on water quality criteria for temperature, dissolved oxygen, ammonia, and antidegradation in the State of Washington in 2003. Water quality criteria establish water column concentrations for various constituents, above which any waters of the State (excluding those waters on Tribal lands) should not exceed for the protection of aquatic life. These criteria will be used to evaluate discharge permits (National Pollution Discharge Elimination System and Total Maximum Daily Limits) and formulate consumption advisories where appropriate. Many states' waters contain elevated levels of toxic pollutants that are present in fish tissues and have resulted in fishing advisories throughout the range of bull trout (www.epa.gov/ost/fish). We do not anticipate formal consultation on current surface water quality standards for nonconventional pollutants in the states of Washington, Oregon, Nevada, and Montana in the near future.

Elevated levels of contaminants may result in either lethal (e.g. mortality) or sublethal effects to bull trout. Sublethal impacts may include reduced egg production, reduced survival of any life stage, reduced growth, impaired osmoregulation, and many subtle endocrine, immune, and cellular changes. Contaminants may also affect the foodchain and indirectly harm bull trout by reducing prey availability due to reduced habitat suitability for prey species. Lethal impacts from contaminant inputs are most likely from spills, whereas sublethal impacts may occur from such land uses as agriculture, residential/urban, mining, grazing, and forestry.

Conservation Measures

At present, there are several State, Federal, Tribal, and Canadian programs and conservation efforts that may help achieve recovery objectives for bull trout in the coterminous United States. Recovery planning for bull trout will proceed under the direction of an overall recovery team as well as individual recovery unit teams working to address bull trout conservation needs in specific geographic locations. Membership of the recovery unit teams has generally been extended to any and all interested parties, including biologists and experts in related disciplines from local, State, Tribal and Federal entities, stakeholder groups representing timber interests, water users, agriculture, power producers and distributors, landowners, conservation groups, tourism advocates and local government. The bull trout recovery planning process has built upon previous State and locally-driven processes throughout the range of the species. Some of these measures are described below.

State Bull Trout Conservation Actions

The following is a brief summary of the existing and ongoing conservation activities by the States of Idaho, Montana, Nevada, Oregon, and Washington.

Idaho. The Idaho Department of Fish and Game, in cooperation with several Federal and State agencies, developed a management plan for bull trout in 1993 (Conley 1993), and the State of Idaho approved the State of Idaho Bull Trout Conservation Plan for the conservation of bull trout in July 1996 (Batt 1996). The Plan identified an overall mission of maintaining or restoring interacting groups of bull trout throughout the species' native range in the State, and four goals to accomplish the mission: (1) maintenance of habitat conditions in areas supporting bull trout, (2) instituting cost-effective strategies to improve bull trout abundance and habitats, (3) establishing stable or increasing bull trout populations in a set of well-distributed sub-watersheds, and (4) providing for the economic viability of industries in Idaho (Batt 1996). The overall approach of the plan was to use existing, locally-developed groups established by Idaho legislation, *i.e.*, watershed advisory groups and basin advisory groups, which were formed to strengthen water quality protection and improve compliance with the Clean Water Act. The draft chapters of the bull trout recovery plan for Idaho rely on information contained in the draft and final problem assessments for the key watersheds developed under the State of Idaho Bull Trout Conservation Plan.

The watershed advisory groups have drafted 21 problem assessments throughout Idaho, which address all 59 key watersheds. To date, a conservation plan has been completed only for the Pend Oreille key watershed.

Angling regulations in Idaho have become more restrictive than in the past. Several conservation actions identified in the problem assessments have been completed or are ongoing, *e.g.*, activities improving bull trout access to habitat, investigations of methods to reduce abundance of nonnative fish species in bull trout habitats, and angler education.

Montana. Development of the bull trout recovery plan in Montana relied heavily upon, and was integrated with, State processes for bull trout conservation that began in 1992 with the implementation of the Montana Bull Trout Restoration planning process and resulted in the Montana Bull Trout Restoration Plan issued in 2000 (MBTRT 2000). In 1993, the Governor of Montana appointed the Montana Bull Trout Restoration Team to produce a plan that maintains, protects, and increases bull trout populations. These sources represent State input, as well as that of local and regional individuals and entities participating in the restoration team, basin workgroups, and the Montana Bull Trout Scientific Group. The team appointed a scientific group, the Montana Bull Trout Scientific Group, to provide the restoration planning effort with technical expertise. The scientific group produced 11 basin-specific status reports (MBTSG 1995a-e, 1996a-f) and 3 technical, peer-reviewed papers concerning the role of hatcheries (MBTSG 1996g), suppression of nonnative fish species (MBTSG 1996h), and land management (MBTSG 1998). A restoration plan, completed in June 2000, defines and identifies strategies for ensuring the long-term persistence of bull trout in Montana and provided the foundation for the Montana portion of the recovery unit chapters.

Watershed groups have been formed in some areas to lead local bull trout restoration efforts, and some habitat restoration projects, such as removal of fish passage barriers, screening irrigation diversions, riparian fencing, stream restoration projects, and habitat monitoring, have been completed or are underway (P. Graham, Montana Fish, Wildlife, Parks, and B. Clinch, Montana Department of Natural Resources and Conservation, *in litt.* 1997). Some recovery measures are occurring throughout the State with funding from State and Federal resource management agencies, as well as from habitat improvement funds (*e.g.*, Montana Fish, Wildlife, Parks Future Fisheries Improvement Program and the U.S. Fish and Wildlife Service's Partners for Fish and Wildlife Program), and from mitigation projects (*e.g.*, in the Clark Fork, Flathead, and Kootenai Rivers). Also, angling regulations have become more restrictive than in the past, brook trout are no longer stocked, and there are ongoing genetic studies to assess bull trout populations.

Nevada. The Nevada Division of Wildlife wrote a Bull Trout Species Management Plan that recommends management alternatives to ensure that human activities will not jeopardize the future of bull trout in Nevada (Johnson 1990). The recommended program identifies actions including bull trout population and habitat inventories, life history research, and potential population reestablishment; State involvement in watershed land use planning; angler harvest assessment; official State sensitive species designation for regulatory protection; nonnative fish stocking evaluation and prohibition; and potential nonnative fish eradications. The Nevada Division of Wildlife scheduled these activities for implementation from 1991 to 2000, although many have yet to be initiated or fully implemented.

State angling regulations have become more restrictive in an attempt to protect bull trout in the Jarbidge River in Nevada. Bull trout harvest prohibitions and reduced daily and possession limits on other trout within the basin are in place throughout the Jarbidge River system. The State has also initiated public and angler awareness and education efforts relative to bull trout identification. The Nevada Division of Wildlife did not stock rainbow trout in the Jarbidge River system in 1999 (G. Weller, Nevada Department of Wildlife, pers. comm. 1999).

Oregon. Since 1990, the State of Oregon has taken several actions to address the conservation and recovery of bull trout. Initially, working groups were established that consisted primarily of State, Federal, and private individuals with bull trout expertise. After gathering initial information, membership on the working groups was expanded when the Oregon Department of Fish and Wildlife bull trout coordinator was hired in 1995, and included a range of people representing affected interests.

More restrictive harvest regulations were implemented beginning in 1990; by 1994 the harvest of bull trout was prohibited throughout the State with the sole exception of Lake Billy Chinook in central Oregon. Bull trout working groups have been established in the Klamath, Deschutes, Hood, Willamette, Odell Lake, Umatilla and Walla Walla, John Day, Malheur, and Pine Creek river basins for the purpose of developing bull trout conservation strategies. The Oregon Department of Fish and Wildlife reduced the stocking of hatchery-reared rainbow trout and brook trout in areas where bull trout occur, and genetic analysis for most bull trout populations was completed in 1997. Angler outreach and education efforts were also implemented in river basins with bull trout. Bull trout identification posters were placed at various campgrounds and trail heads, and bull trout identification cards were produced for distribution by the Malheur National Forest and the Oregon Department of Fish and Wildlife. Research to examine life history, genetics, habitat needs, and limiting factors of bull trout in Oregon was initiated in 1995, supported by funding from the Fish and Wildlife Program of the Northwest Power Planning Council. In 1998, a project was initiated to transfer bull trout fry from the McKenzie River watershed to the adjacent Middle Fork Willamette River, which is historical unoccupied, isolated habitat. Recent surveys documented several age classes of bull trout at release sites in the Middle Fork Willamette River.

The Oregon Department of Environmental Quality sets standards for water quality and administers Oregon's water quality program. Surface water temperatures may not exceed 10.0 degrees Celsius (50.0 degrees Fahrenheit) in waters that support or are necessary to maintain the viability of bull trout (Oregon 1996).

On January 14, 1999, Governor Kitzhaber expanded the Oregon Plan for Salmon and Watersheds (Oregon 1997) to include all at-risk wild salmonids throughout the State. The goal of the Oregon Plan is to "restore populations and fisheries to productive and sustainable levels that will provide substantial environmental, cultural, and economic benefits". Components of this plan include (1) coordination of efforts by all parties, (2) development of action plans with relevance and ownership at the local level, (3) monitoring progress, and (4) making appropriate corrective changes in the future. This process included chartering 84 locally-formed and represented “watershed councils” across the State. Membership on the watershed councils includes: landowners, businesses interests, agricultural interests, sport fishers, irrigation/water districts, individuals, State, Federal, and Tribal agencies, and local government officials. Information on watershed conditions prepared by local councils and working groups has been applied to developing bull trout recovery unit chapters in Oregon.

Washington. The draft Statewide Strategy to Recover Salmon, Extinction is not an Option, produced by the Washington Governor's Salmon Recovery Office (Washington Governor's Salmon Recovery Office 1999) and Joint Natural Resources Cabinet, served as the template for recovery unit chapters in the Washington portion of the bull trout recovery plan. While the Washington Governor's plan focuses primarily on salmon, many of the same factors affecting salmon also impact bull trout. The plan describes how State agencies and local governments will work together to address habitat, harvest, hatcheries, and hydropower as they relate to recovery of listed species. Overall goals and strategies identified in this document for restoring healthy populations of salmon are consistent with actions needed for bull trout recovery. In addition, recovery unit teams incorporated information from the Washington State Salmonid Inventory for Bull Trout/Dolly Varden (WDFW 1998) and the Bull Trout and Dolly Varden Management Plan (WDFW 2000), both prepared by the Washington Department of Fish and Wildlife.

The Washington State legislature established the Salmon Recovery Act (ESHB 2496) and Watershed Management Act (ESHB 2514) to assist in salmon recovery efforts. The Watershed Management Act provided funding and a planning framework for locally based watershed management addressing water quality and quantity. The Salmon Recovery Act provides the direction for the development of limiting factors analyses on salmon habitat and creates a list of prioritized restoration projects at the major watershed level. While not specifically targeting limiting factors for bull trout, these documents have played an important role in the development of bull trout recovery unit chapters. As offshoots of the Statewide Strategy to Recover Salmon, members of the Lower Columbia Fish Recovery Board and the Upper Columbia Salmon Recovery Board have been involved in the development and review of bull trout recovery unit chapters.

The Washington Department of Fish and Wildlife no longer stocks brook trout in streams or lakes connected to bull trout waters. Fishing regulations prohibit harvest of bull trout, except for a few areas where stocks are considered "healthy," within the State. The Washington Department of Fish and Wildlife is also currently involved in a mapping effort to update bull trout distribution data within the State of Washington, including all known occurrences, spawning and rearing areas, and potential habitats. The salmon and steelhead inventory and assessment program is currently updating their database to include the entire State, which consists of an inventory of stream reaches and associated habitat parameters important for the recovery of salmonid species and bull trout.

In January 2000, the Washington Forest Practices Board (2000) adopted new emergency forest practice rules based on the "Forest and Fish Report" development process. These rules address riparian areas, roads, steep slopes, and other elements of forest practices on non-Federal lands. Although some provisions of forest practice rules represent improvements over previous regulations, the plan relies on an adaptive management program for assurance that the new rules will meet the conservation needs of bull trout. Research and monitoring being conducted to address areas of uncertainty for bull trout include protocols for detection of bull trout, habitat suitability, forestry effects on groundwater, field methods or models to identify areas influenced by groundwater, and forest practices influencing cold water temperatures. The Forest and Fish Report development process relied on broad stakeholder involvement and included State agencies, counties, Tribes, forest industry and environmental groups. A similar process is also being used for agricultural communities in Washington and is known as "Agriculture, Fish, and Water."

Overall, the States within the range of bull trout have developed, or are engaged in developing, conservation plans or strategies for the species. The U.S. Fish and Wildlife Service has, and continues to, encourage States to implement strategies and conservation actions that benefit bull trout.

Federal Activities

Endangered Species Act. Bull trout in the coterminous United States occur on lands administered by the Federal Government (*e.g.*, Bureau of Land Management, Forest Service, and National Park Service), various State-owned properties, and private and Tribal lands. The majority of bull trout spawning and rearing habitat occurs on Federal lands. Federal agency actions that occur on Federal lands or elsewhere with Federal funds or authorization may require consultation under the Endangered Species Act. These actions include U.S. Army Corps of Engineers involvement in projects such as the construction of roads and bridges, the permitting of wetland filling and dredging projects subject to section 404 of the Clean Water Act, construction, maintenance, and operation of dams and hydroelectric plants; Federal Energy Regulatory Commission-licensed hydropower projects authorized under the Federal Power Act; Forest Service and Bureau of Land Management timber, grazing, and recreation management activities; Environmental Protection Agency-authorized discharges under the National Pollutant Discharge Elimination System of the Clean Water Act; U.S. Housing and Urban Development projects; U.S. Bureau of Reclamation projects; and National Park Service activities. Because there are various policies, directives, and regulations providing management direction to Federal agencies and opportunities to conserve bull trout, *e.g.*, roadless area conservation on

Forest Service lands (66 FR 3244), we provide the following types of activities as examples.

Bull Trout Interim Conservation Guidance. The purpose of the Bull Trout Interim Conservation Guidance is to provide U.S. Fish and Wildlife Service biologists with a tool that is useful in conducting Endangered Species Act activities, including section 7 consultations, negotiating Habitat Conservation Plans that culminate in the issuance of section 10(a)(1)(B)-incidental take permits (see section 10(a)(1) discussion below), issuing recovery permits, and providing technical assistance in forest practice rule development and other interagency bull trout conservation and recovery efforts. This document is not intended to supersede any biological opinion that has been completed for Federal agency actions. Rather, it should be used as another tool to assist in consultation on those actions.

PACFISH/INFISH. Land management plans for the Bureau of Land Management and Forest Service lands within the range of bull trout have been amended by the Interim Strategy for Managing Anadromous Fish-producing Watersheds in Eastern Oregon and Washington, Idaho, and Portions of California (PACFISH; USDA and USDI 1995) and the Interim Strategy for Managing Fish-producing Watersheds in Eastern Oregon and Washington, Idaho, Western Montana and Portions of Nevada (INFISH; USDA 1995). PACFISH, developed by the Bureau of Land Management and Forest Service, is intended to be an ecosystem-based, aquatic habitat and riparian-area management strategy for Pacific salmon, steelhead, and sea-run cutthroat trout habitat on lands administered by the two agencies that are outside the area subject to the Northwest Forest Plan. INFISH was developed by the Forest Service to provide an interim strategy for inland native fish in areas outside those where PACFISH and the Northwest Forest Plan apply. The U.S. Fish and Wildlife Service issued a programmatic non-jeopardy biological opinion on land and resource management plans of the Bureau of Land Management and Forest Service, as amended by PACFISH and INFISH, for the Klamath and Columbia River population segments of bull trout that endorsed implementation of additional commitments made by the two agencies (USFWS 1998b). The commitments included habitat restoration and improvement; standards and guidelines of PACFISH and INFISH; evaluation of key and priority watershed networks; completion of watershed analysis and monitoring; establishing goals for long-term conservation and recovery; and conducting section 7 consultation at the watershed level. The biological opinion also identified additional actions to help ensure conservation of bull trout. Consultations for site-specific actions are continuing, as are consultations for land and resource management plans in other bull trout population segments.

In December, 1998, the regional executives for the U.S. Fish and Wildlife Service, National Marine Fisheries Service, U.S. Forest Service and Bureau of Land Management chartered The Interagency Implementation Team. This Team is integral to the implementation of PACFISH and INFISH, under the direction of the regional executives, and is responsible for coordinating implementation of the biological opinions on the effects of the aquatic conservation strategies on listed salmon, steelhead and bull trout. The Team has directed the development of a PACFISH/INFISH Monitoring Task Team to develop a monitoring program for tracking implementation and effectiveness of PACFISH/INFISH.

Northwest Forest Plan. On April 13, 1994, the Secretaries of the Department of Agriculture and the Department of the Interior adopted the Northwest Forest Plan for management of late-successional forests within the range of the northern spotted owl. This plan contains objectives, standards, and guidelines to provide for a functional late-successional and old-growth forest ecosystem. Included in the plan is an aquatic conservation strategy involving riparian reserves, key watersheds, watershed analysis, and habitat restoration. The U.S. Fish and Wildlife Service issued a programmatic non-jeopardy biological opinion on the plan for the Coastal-Puget Sound, Columbia River, and Klamath River population segments of bull trout (USFWS 2000). The biological opinion also identified additional actions to be taken by the Federal land managers to help ensure conservation of bull trout. These actions included clearly documenting that proposed actions are consistent with the aquatic conservation strategy objectives, developing and implementing guidance for reducing effects of road management programs on bull trout, and responding quickly to mining notices on lands administered by the Bureau of Land Management in order to advise operators how to prevent adverse effects to bull trout. Consultations for site-specific actions are ongoing.

Federal Columbia Power System Biological Opinion. On December 15, 2000, the U.S. Fish and Wildlife Service issued a biological opinion to the U.S. Army Corps of Engineers, Bureau of Reclamation, and Bonneville Power Administration on the operation and maintenance of Federal hydroelectric and water storage dams within the Columbia River basin. The biological opinion was developed after consultations with the U.S. Army Corps of Engineers and the Bureau of Reclamation, which operate the Federal dams, and the Bonneville Power Administration, which sells the electricity generated at the dams. The dams included in the biological opinion are: Bonneville, The Dalles, John Day and McNary dams (Lower Columbia River facilities); Ice Harbor, Lower Monumental, Little Goose, Lower Granite and Dworshak dams (Lower Snake River and Clearwater facilities); Grand Coulee, Albeni Falls, Libby, Hungry Horse, and Chief Joseph dams and Banks Lake Pump Storage (Upper Columbia River facilities). These projects are located in the states of Oregon, Washington, Idaho, and Montana.

Impacts to bull trout occur mostly in the upper reaches of the Columbia River basin and the biological opinion recommended changes in operations that focus on the Upper Columbia River dams. Bull trout are known to occur in the mainstem

Columbia and lower Snake Rivers but their use of these areas is not well known (See the discussion of the mainstem Columbia and lower Snake Rivers in section G, Strategy for Recovery.) The focus of the consultations on operations at Libby and Hungry Horse dams and their effects to bull trout has been on 1) ramping rates; 2) minimum flows; 3) seasonal water management; 4) total dissolved gas concerns; and 5) fish passage and entrainment. The action agencies and the U.S. Fish and Wildlife Service have agreed on the need for ramping rates and minimum flows. Operations at Albeni Falls Dam to benefit kokanee salmon, a key food source for bull trout in Lake Pend Oreille, are also addressed in this opinion.

Coordination between the National Marine Fisheries Service and the U.S. Fish and Wildlife Service has been ongoing during the preparation of the draft and final biological opinions for the Federal Columbia River Power System. Specifically, the National Marine Fisheries Service and the U.S. Fish and Wildlife Service have agreed to operations (ramping rates and minimum flows) at Hungry Horse and Libby dams that will benefit all resident species, and implementation of modified flood control operations at both dams to store additional water for resident fish and salmon. In low water years, the agencies have agreed to work out details of operation through the Technical Management Team process to balance the needs of listed species.

The U.S. Fish and Wildlife Service has also been coordinating with the Montana Department of Fish, Wildlife and Parks to better address listed species and reservoir management issues. Specifically, the U.S. Fish and Wildlife Service, National Marine Fisheries Service, and the action agencies, in coordination with Montana Department of Fish, Wildlife and Parks, have slightly revised the minimum flows and ramping rates to address Montana Department of Fish, Wildlife and Parks concerns. Other Columbia River basin consultations are addressing or have addressed operations of Federal dams and related activities in tributaries, including the Yakima, Willamette, and the Umatilla river basins, and in the Snake River upstream of Lower Granite Reservoir.

Section 10(a)(1) Permits. Permits, authorized under section 10(a)(1) of the Endangered Species Act, may be issued to carry out otherwise prohibited activities involving endangered and threatened wildlife under certain circumstances. Permits are available for scientific purposes to enhance the propagation or survival of a species and for incidental "take" (harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect a listed species) in connection with otherwise lawful activities. Private landowners seeking permits for incidental take offer a means of protecting bull trout habitat through the voluntary development of Habitat Conservation Plans and Safe Harbor Agreements.

Habitat Conservation Plans. Incidental take permits are required when non-Federal activities will result in "take" of threatened or endangered species. A habitat conservation plan must accompany an application for an incidental take permit. The purpose of the Habitat Conservation Planning process is to ensure there is adequate minimization and mitigation of effects from the authorized incidental take. The purpose of the incidental take permit is to authorize the incidental take of a listed species. For example, the Plum Creek Timber Company developed a Habitat Conservation Plan with the U.S. Fish and Wildlife Service addressing bull trout and other native salmonids occurring on over 688,500 hectares (1.7 million acres) of corporate lands, primarily in the Columbia River basin. The majority of the land under consideration occurs in Montana (87 percent) with the remainder in Idaho and Washington.

Because silvicultural activities, logging road construction and maintenance, and open range cattle grazing by the Plum Creek Timber Company may result in harm to bull trout, seven categories of conservation commitments were included in the Habitat Conservation Plan. The seven categories are: (1) road management, (2) riparian management, (3) livestock grazing, (4) land-use planning, (5) legacy management and other restoration opportunities, (6) administration and implementation measures, and (7) monitoring and adaptive management. The conservation benefits of activities in the seven categories include reducing sediment delivery to streams from roads and grazing, increasing canopy cover in riparian areas, restoring stream bank integrity and overall habitat complexity, and providing fish passage at road culverts and water diversion structures.

In Washington, the Washington Department of Natural Resources developed a Habitat Conservation Plan that was adopted on January 1, 1999. The plan covers the approximately 647,500 hectares (1.6 million acres) of forested State trust lands that lie within the range of the northern spotted owl. The Habitat Conservation Plan contains riparian conservation strategies that were designed to protect salmonid and riparian species for lands west of the Cascade Mountains crest. It includes a streamside no-harvest buffer strategy, a minimal-harvest area for ecosystem restoration, and a low-harvest area for selective removal of single trees or groups of trees and thinning and salvage operations. In addition to riparian buffers, road management standards were developed to ensure that mass-wasting (erosion and landslides) is not artificially accelerated and that sediment delivery remains near natural levels. The Habitat Conservation Plan also includes monitoring and adaptive management components. The minimization and mitigation actions of the plan will address habitat requirements of bull trout and cumulatively will reduce the adverse effects to bull trout in comparison to previous forest management practices (USFWS 1998d).

Safe Harbor Agreements. Safe Harbor Agreements between the U.S. Fish and Wildlife Service and non-Federal landowners are another voluntary mechanism to encourage conservation of listed species and authorize incidental take permits. In general, these agreements provide (1) conservation benefits for listed species that would otherwise not occur except for the agreement, and (2) Endangered Species Act regulatory assurances to the landowner through a section 10 permit. Safe Harbor Agreements are intended for landowners who have few or no listed species (or listed species' suitable habitat) on their property, but who would be willing to manage their property in such a way that listed species may increase on their lands, as long as they are able to conduct their intended land-use activities. An example of how Safe Harbor Agreements may be used to further bull trout conservation can be found with fish passage barriers in streams. If a landowner owns a stream with a fish passage barrier that prevents access to their property by bull trout, they may be unwilling to remove the barrier, and thereby allow access by bull trout, for fear of the "take" prohibitions under section 9 of the Endangered Species Act and potential restrictions on land-use activities. Under a Safe Harbor Agreement, the landowner would agree to removal of the barrier, allow bull trout access to their property, and the landowner and U.S. Fish and Wildlife Service would negotiate other conservation measures necessary to ensure suitable bull trout habitat conditions are maintained on the property while allowing the landowner's land-use activities to occur. The landowner would receive a section 10 permit authorizing incidental take of bull trout consistent with the agreed upon conservation measures in the Safe Harbor Agreement. Safe Harbor Agreements for bull trout may be developed in the future.

Clean Water Act. The Clean Water Act provides some regulatory mechanisms for protection and restoration of water quality in waters that support bull trout. Under sections 303 and 304, states or the Environmental Protection Agency set water quality standards, which combine designated beneficial uses and criteria established to protect uses. States or the Environmental Protection Agency designate water bodies that are failing water quality standards as water quality limited under section 303(d) (*e.g.*, MDHES 1994; USEPA 1994; ODEQ 1996), and are required to develop management plans. Management plans include total maximum daily loads with implementation plans that define site-specific actions and timelines for meeting water quality goals (65 FR 43586). The total maximum daily loads assess and allocate all the point and nonpoint sources of pollutants within a watershed. Best management practices are used with total maximum daily loads to address nonpoint sources of pollution, such as mining, forestry, and agriculture. Regulatory authority to enforce the best management practices, however, varies among the states. It is estimated that 10 percent of the total length of streams within the interior Columbia River basin and the Klamath River basin are listed as water quality limited, and this estimate may be below the true extent and distribution of streams with impaired water quality potentially affecting bull trout (USDA and USDI 1997). The U.S. Environmental Protection Agency requests that states give higher priority to polluted waters that are sources of drinking water or support listed species, when developing total maximum daily loads and implementation plans (65 FR 43586).

In accordance with section 319 of the Clean Water Act, states also develop programs to address nonpoint sources of pollution such as agriculture, forestry, and mining. The effectiveness of controlling water pollution from these activities has been mixed. The State of Washington monitored the effectiveness of riparian prescriptions under past forest practices regulations in meeting water quality temperature criteria for streams on forest lands and concluded that regulations for stream shading were inadequate to meet criteria (Sullivan *et al.* 1990).

Northwest Power Planning Council Fish and Wildlife Program. Congress, through the Pacific Northwest Electric Power Planning and Conservation Act of 1980, directed the Northwest Power Planning Council to develop a Fish and Wildlife Program. The program is intended to give the citizens of Idaho, Montana, Oregon, and Washington a stronger voice in the future of electricity generated by the Federal hydropower dams in the Columbia River basin and fish and wildlife affected by the dams and their operation.

One of the Northwest Power Planning Council's major responsibilities is to develop a program to protect and rebuild fish and wildlife populations affected by hydropower development in the Columbia River basin. State, Tribal, and local governments often work closely with the Northwest Power Planning Council as it develops power and fish and wildlife plans. The Bonneville Power Administration provides funding for implementation of the Council's Fish and Wildlife Program. In 2000, the Council amended its Fish and Wildlife Program to include development of subbasin plans. Subbasin planning, beginning in 2002, is a means for identifying projects that will be funded to protect, mitigate, and enhance the Columbia River basin's fish and wildlife resources. These plans are viewed as crucial efforts for implementing the Endangered Species Act responsibilities of the Bonneville Power Administration, U.S. Corps of Engineers, and the Bureau of Reclamation in the Columbia River basin.

The primary objective of subbasin planning is to develop a unifying element for implementation of the Northwest Power Planning Council's Fish and Wildlife Program. It will also assist in the implementation of Endangered Species Act recovery activities. One of the goals of the subbasin planning process is to provide specific products that can be integrated directly into the Endangered Species Act recovery planning process. We will provide specific recovery unit chapters from the bull trout recovery plan to the applicable subbasin planning teams that have the responsibility for developing subbasin plans.

Federal Caucus Fish and Wildlife Plan. The Federal Caucus is a group of nine Federal agencies, formed as a result of the Federal Columbia Power System Biological Opinion, that have responsibilities for natural resources affecting species listed under the Endangered Species Act. The agencies are the National Marine

Fisheries Service, U.S. Fish and Wildlife Service, Bureau of Reclamation, Bonneville Power Administration, U.S. Army Corps of Engineers, Bureau of Indian Affairs, Forest Service, Bureau of Land Management, and Environmental Protection Agency. The Federal Caucus has drafted a basin-wide recovery strategy for listed anadromous fish in the Columbia River basin which addresses management of habitat, hatcheries, harvest, and hydropower. This recovery strategy, titled ‘The Conservation of Columbia River Basin Fish: Final Basin-Wide Recovery Strategy’, will provide the framework for development of recovery plans for individual species and for effects determinations for actions under consultation. As recovery plans for individual species are developed following the basin-wide strategy, and measures to address biological needs of all stages of the life cycle are implemented, conditions for listed aquatic species are expected to improve sufficiently to provide for their survival and recovery. The Basin-Wide Salmon Recovery Strategy concludes that restoring tributary and estuary habitat is key to recovering listed fish. Actions focus on restoring tributary (both Federal and non-Federal), mainstem, and estuary habitat. The Salmon River basin would be a target for recovery efforts under this strategy.

For long-term actions, the Basin-Wide Salmon Recovery Strategy endorses the Northwest Power Planning Council strategy of conducting subbasin assessments and developing subbasin plans and prioritizing actions based on those plans. Once the assessments are complete, the Federal agencies will participate with State agencies, local governments, Tribes and stakeholders to develop subbasin plans. Draft subbasin summaries were used extensively in the preparation of bull trout recovery unit chapters.

While the salmon recovery framework has only recently been adopted, and thus the benefits of this recovery framework have not yet been realized, the U. S. Fish and Wildlife Service envisions significant improvements in habitat conditions for listed salmonids as recovery activities are implemented. Because bull trout often use the same areas, we expect bull trout to similarly benefit from improved habitat conditions.

U.S. Department of Agriculture. The U.S. Department of Agriculture offers landowners financial, technical, and educational assistance to implement conservation practices on privately owned land. Using this help, farmers and ranchers apply practices that reduce soil erosion, improve water quality, and enhance forest land, wetlands, grazing lands, and wildlife habitat. U.S. Department of Agriculture assistance also helps individuals and committees restore after floods, fires, or other natural disasters.

This assistance is provided to landowners via Farm Bill programs administered by the U.S. Department of Agriculture, Farm Service Agency and the Natural Resources Conservation Service. The implementation of practices associated with these programs may improve conditions for bull trout. In particular, the Conservation Reserve Enhancement Program is targeted to areas in Oregon and Washington where other listed fish occur and may provide direct benefits to bull trout.

The Conservation Reserve Easement Program is an addition to the Conservation Reserve Program. A Conservation Reserve Enhancement Program for the State of Oregon and the State of Washington was approved October 1998, in a Memorandum of Agreements between the United States Department of Agriculture, the Commodity Credit Corporation and the states of Oregon and Washington. The Conservation Reserve Easement Program is a partnership between Federal agencies, State agencies, and private landowners. Land enrolled in this program is removed from production and grazing, under 10 to 15 year contracts. In return, landowners receive annual rental, incentive, maintenance and cost share payments.

The Oregon Conservation Reserve Easement Program is a voluntary program offering annual payments to landowners for establishment of riparian buffers along streams and for restoration of wetlands. The Oregon Conservation Reserve Easement Program seeks to enroll up to 40,469 hectares (100,000 acres) located along streams inhabited (or once inhabited) by listed fish under Federal law as threatened or endangered. Up to 5,000 of these acres may be cropped wetlands which are either hydrologically connected to these streams or located in coastal estuaries.

In Washington, eligible stream designations were originally based on spawning habitat for stocks designated as critical or depressed under the 1993 Salmon and Steelhead Stock Inventory. Approximately 9,656 kilometers (6,000 miles) of eligible streams were included. Recent changes allow for the nomination of additional stream segments where riparian habitat is a significant limiting factor, and a new cap of 16,093 kilometers (10,000 miles) of eligible streams.

Other Farm Bill programs encourage farmers to convert highly erodible cropland or other environmentally sensitive acreage to native vegetative cover, provide incentives for landowners to restore function and value to degraded wetlands on a long-term or permanent basis, assist landowners with habitat restoration and management activities specifically targeting fish and wildlife (including threatened and endangered species), provide technical and financial assistance to farmers and ranchers that face threats to soil, water, and related natural resources, and support forest management practices on privately owned, nonindustrial forest lands.

Native American Tribal Activities

In Oregon, members of the Confederated Tribes of the Umatilla Reservation, Confederated Tribes of the Warm Springs Reservation, Burns Paiute Tribe, and Klamath Tribe all participate on bull trout working groups in their geographic areas of interest. The Confederated Tribes of the Warm Springs Reservation and the Burns Paiute Tribe both have projects funded through the Bonneville Power Administration focused on bull trout. The Confederated Tribes of the Umatilla Indian Reservation has multiple projects funded through the Bonneville Power Administration that address anadromous fish, but that also benefit bull trout, *e.g.*, habitat surveys, passage at dams and diversions, habitat improvement, and movement studies.

In Montana, the Confederated Salish and Kootenai Tribes were a full participant in the Montana Bull Trout Restoration Team and the Montana Bull Trout Scientific Group. They have been actively involved in recovery unit teams for the Clark Fork River Recovery Unit, including activities both on and off the Flathead Reservation. The Blackfeet Nation will be a pivotal player in the St. Mary-Belly River Recovery Unit Team. Much of the St. Mary River drainage in Montana occurs on Tribal lands.

In Idaho, the Coeur d'Alene Tribe, Kootenai Tribe of Idaho, Nez Perce Tribe, and Shoshone-Bannock Tribe are participating on various recovery unit teams.

The Spokane Tribe, Confederated Tribes of the Colville Reservation, and Kalispel Tribe participated in the Northeast Washington Recovery Unit Team. The Kalispel Tribe has projects funded through the Bonneville Power Administration, Salmon Recovery Funding Board, and Pend Oreille County Public Utility District that benefit bull trout (*e.g.*, habitat surveys and habitat improvement projects). The Yakama Nation participates on the Mid, Upper, and Lower Columbia recovery units teams. The Yakama Nation has many projects that address anadromous fish, but that also benefit bull trout (*e.g.*, habitat surveys, habitat improvement projects, and passage at dams and diversions). In western Washington, the Quinault Indian Nation and the Skokomish Tribe participate in the Olympic Peninsula Recovery Unit Team for the Coastal-Puget Sound population segment of bull trout. The Stillaguamish Tribe and Nooksack Tribe participate in the Puget Sound Recovery Unit Team. These Tribes as well as other Tribes within western Washington are currently involved in habitat restoration, watershed assessment, habitat and fisheries monitoring, and management forums focused on recovery and maintenance of anadromous salmon populations within the Puget Sound region and on the Washington Coast. Many of these efforts will also benefit bull trout.

Canadian Government Activities

Bull trout currently receive no legal protection in Canada, although legislation to protect wildlife species at risk has been introduced in the House of Commons. The provinces of Alberta (Berry 1994) and British Columbia (British Columbia Environment 1994) have both developed strategic plans for the recovery of bull trout. Both provinces have increased research and management efforts for the species in recent years and have implemented site-specific activities to improve bull trout habitat, increase migratory capabilities, and enforce stricter angling regulations. Alberta has adopted bull trout as the Provincial fish and has developed an extensive public relations campaign.

STRATEGY FOR RECOVERY

Recovery of bull trout will require reducing threats to the long-term persistence of self-sustaining, complex interacting populations of bull trout across the species' native range, and preserving the diversity of bull trout life-history strategies (*e.g.*, resident or migratory forms, emigration age, spawning frequency, local habitat adaptations). Migratory fish allow genetic exchange between populations and colonization of unoccupied habitats.

The main threats to bull trout persistence are habitat fragmentation and degradation, passage barriers that isolate populations, competition and predation from nonnative fishes, angling mortality, and effects resulting from isolation and small population sizes. The recovery strategy is to restore habitats and connectivity, reduce effects of nonnative fishes, and reduce angling mortality (Table 2) . Restoring bull trout habitats will require identifying habitats for all bull trout life history stages; identifying site-specific threats (*e.g.*, unsuitable water quality and habitat conditions); and protecting, restoring, and maintaining suitable watershed, riparian area, and stream channel habitats. Restoring connectivity will require identifying and correcting passage barriers, where appropriate (*e.g.*, where restoring passage would not encourage invasion of nonnative species). Restoring habitats and providing passage will also provide opportunities for genetic exchange among local populations and expand the resources available to bull trout.

Development of standardized guidance for monitoring and assessment of bull trout populations is an important component of the recovery strategy. Accurate assessment of population trends, distribution, and response to recovery actions is essential for evaluating recovery implementation. For instance, the recovery criterion - "stable or increasing trends for adult bull trout abundance" requires estimating the magnitude and direction of the population trend. Estimates made for current conditions can be compared to estimates made at some future time to evaluate whether implemented actions have contributed to recovery and can also help identify which recovery units or core areas require the most protection, or most urgent action.

Table 2. Relationship of Recovery Actions and Criteria to Threats and Listing Factors to Bull Trout Recovery Planning.

LISTING FACTOR	THREAT	RECOVERY CRITERIA*	RECOVERY ACTIONS
A	Dams	1,2,,3,4	1.2 barriers, 1.4dam operation, 5.1monitor recovery efforts, 5.2research BT abundance, habitat & tasks, 5.5improve info on distribution & status, 7.1-3assess implementation by recovery units & revise plans
A	Forest Management Practices	1,2,,3	1.1water quality, 1.3 restore stream & riparian, 5.1monitor recovery efforts, 5.2research BT abundance, habitat & tasks, 5.3evaluate BMP’s for habitat, 6.1use partnerships to protect & restore core area functions, 7.1-3assess implementation by recovery units & revise plans
A	Livestock Grazing	1,2,,3	1.1water quality 1.3 restore stream & riparian, 5.1monitor recovery efforts, 5.2research BT abundance, habitat & tasks, 5.3evaluate BMP’s for habitat, 6.1use partnerships to protect & restore core area functions, 7.1-3assess implementation by recovery units & revise plans
A	Agricultural Practices	1,2,,3,4	1.1water quality 1.2 barriers 1.3 restore stream & riparian, 5.1monitor recovery efforts, 5.2research BT abundance, habitat & tasks, 5.3evaluate BMP’s for habitat, 6.1use partnerships to protect & restore core area functions, 7.1-3assess implementation by recovery units & revise plans
A	Road Construction and Maintenance	1,2,,3,4	1.1water quality 1.2 barriers, 5.1monitor recovery efforts, 5.2research BT abundance, habitat & tasks, 5.3evaluate BMP’s for habitat, 6.1use partnerships to protect & restore core area functions, 7.1-3assess implementation by recovery units & revise plans
A	Mining	1,2,,3,4	1.1water quality 1.3 restore stream & riparian, 5.1monitor recovery efforts, 5.2research BT abundance, habitat & tasks, 5.3evaluate BMP’s for habitat, 6.1use partnerships to protect & restore core area functions, 7.1-3assess implementation by recovery units & revise plans

LISTING FACTOR	THREAT	RECOVERY CRITERIA*	RECOVERY ACTIONS
A	Residential Development	1,2,,3,4	1.1water quality 1.2 barriers 1.3 restore stream & riparian, 5.2research BT abundance, habitat & tasks, 5.3evaluate BMP's for habitat, 6.1use partnerships to protect & restore core area functions, 7.1-3assess implementation by recovery units & revise plans
B	Illegal and incidental harvest	1,2,,3	3.1fish mngmt. plans, 3.2evaluate angling, 3.3evaluate fisheries effects 3.4evaluate sport fishing reg.s, 5.1monitor recovery efforts, 7.1-3assess implementation by recovery units & revise plans
C	Interspecific interactions, including predation where non-native salmonids are introduced	1,2,,3	2.1 fish stocking, 2.2 illegal transport, 2.3educate about illegal intro., 2.4effects of non-native control, 2.5control non-native, 2.6tasks to reduce effects, 3.3evaluate fisheries effects, 5.1monitor recovery efforts, 6.1use partnerships to protect & restore core area functions, 7.1-3assess implementation by recovery units & revise plans
C	Disease(not currently a threat, but will be monitored)		5.4evaulate effects of disease & parasites & minimize effects
D	The Inadequacy of Existing Regulatory Mechanisms	1,2,,3,4	1.1water quality 2.1 fish stocking, 2.2 illegal transport, 2.5control non-native, 3.1fish mngmt. plans, 3.2evaluate angling, 3.4evaluate sport fishing reg.s, 4.1incoporate genetic conservation, 4.3genetic plans for transplantation & propagation, 5.1monitor recovery efforts, 5.3evaluate BMP's for habitat, 5.5improve info on distribution & status, 6.1use partnerships to protect & restore core area functions, 6.2use Federal authorities for BT, 6.3enforce reg.'s & evaluate, 7.1-3assess implementation by recovery units & revise plans
E	Introduced Non-native species	1,2,,3	2.1 fish stocking, 2.2 illegal transport, 2.3educate about illegal intro., 2.4effects of non-native control, 2.5control non-native, 2.6tasks to reduce effects, 3.3evaluate fisheries effects, 5.1monitor recovery efforts, 7.1-3assess implementation by recovery units & revise plans

LISTING FACTOR	THREAT	RECOVERY CRITERIA*	RECOVERY ACTIONS
E	Isolation and Habitat Fragmentation	1,2,,3,4	1.2 barriers, 1.4dam operation, 4.2mainatin gene flow, 4.3genetic plans for transplantation & propagation, 5.1monitor recovery efforts, 5.2research BT abundance, habitat & tasks, 5.3evaluate BMP's for habitat, 5.5improve info on distribution & status, 5.6improve understanding of genetics & local populations, 6.1use partnerships to protect & restore core area functions, 7.1-3assess implementation by recovery units & revise plans

Listing Factors:
A. The Present or Threatened Destruction, Modification, or Curtailment Of Bull Trout Habitat or Range
B. Overutilization for Commercial, Recreational, Scientific, Educational Purposes
C. Disease or Predation (disease not a major factor)
D. The Inadequacy of Existing Regulatory Mechanisms
E. Other Natural or Manmade Factors Affecting Its Continued Existence
Recovery Criteria * *All recovery units meet their criteria, as identified in the recovery unit chapters.*
1. The distribution of bull trout in identified and potential local populations in all core areas within the recovery unit
2.The estimated abundance of adult bull trout within core areas in the recovery unit, expressed as either a point estimate or a range of individuals
3. The presence if stable or increasing trends for bull trout abundance in the recovery unit
4. The restoration of passage at specific barriers identified as inhibiting recovery.
Tasks - General (see plan for details)
1 - Protect, restore, and maintain suitable habitat conditions for bull trout
2 - Prevent and reduce negative effects of non-native fishes and other non-native taxa on bull trout
3 - Establish fisheries management goals and objectives compatible with bull trout recovery, and implement practices to achieve goals.
4 - Characterize, conserve, and monitor genetic diversity and gene flow among local populations of bull ttrout.
5 - Conduct research and monitoring to implement and evaluate bull trout activities, consistent with an adaptive management approach using feedback from implemented site-specific recovery tasks.
6 - Use all available conservation programs and regulations to protect and conserve bull trout and bull trout habitats.
7 - Assess the implementation of bull trout recovery by recovery units, and revise recovery unit plans based on evaluations.

Research is also an important component of the recovery strategy. Conducting research on the biological and habitat responses to recovery actions will improve on-the-ground application of future actions through adaptive management. Research will also be necessary to develop monitoring programs.

Ultimately, bull trout recovery is dependent upon using cooperative partnerships and interagency collaboration. Because most bull trout habitats occur on federally-managed lands, more opportunities and responsibilities to conserve bull trout under the Endangered Species Act occur on these lands compared to those under other ownerships. The U.S. Fish and Wildlife Service developed land management guidance (USFWS 1998c) promoting bull trout conservation to assist in consultations while this draft recovery plan was being developed. The U.S. Fish and Wildlife Service recommends consideration of the guidance, as well as the management direction and intent contained in PACFISH, INFISH, Northwest Forest Plan, and additional conservation provisions (summarized in Appendix 3), by Federal agencies when planning and implementing activities affecting bull trout and bull trout habitats.

Habitat and Population Terminology

Various terms to describe bull trout habitat and population units have been used in the literature, agency reports, and documents for ongoing conservation efforts. In many instances there is considerable overlap and ambiguity in the terminology. To ensure consistency throughout the recovery plan and define the scope of recovery, we developed standardized terminology for bull trout habitat and population units. Terms for population units are hierarchical, allowing recovery efforts to be focused at various spatial scales.

Local populations: Groups of bull trout that spawn in various tributaries are generally characterized by relatively small amounts of genetic diversity within a tributary but high levels of genetic divergence between tributaries (Leary *et al.* 1993; Taylor *et al.* 1999; Spruell *et al.* 2000). This suggests that many bull trout have a high fidelity (attachment) to specific streams (Kanda and Allendorf 2001) and can be characterized as local populations. The results of many studies support the hypothesis that many streams support local populations that are isolated reproductively (Kanda *et al.* 1997; Kanda 1998; Spruell *et al.* 1999; Kanda and Allendorf 2001; Neraas and Spruell 2001). As noted by Spruell *et al.* (1999), these widespread patterns of genetic variation most likely reflect historical population structures, past evolutionary events, and the general life history of bull trout.

Core Areas: The recovery plan considers local populations of bull trout to be partially isolated, but have some degree of gene flow among them. Such groups meet the definition of (Meffe and Carrol 1994) and function as (Dunham and Rieman 1999) a metapopulation. The intent of the recovery plan is to have core areas reflect the metapopulation structure of bull trout. Within a bull trout metapopulation, local populations are expected to function as one demographic unit (Hanski and Gilpin 1997). All local populations within a bull trout metapopulation would be at a common risk of extinction and have a relatively high degree of genetic relatedness (Kanda and Allendorf 2001). In theory, bull trout metapopulations can be composed of two or more local populations. However, Rieman and Allendorf (2001) have suggested that between 5 and 10 local populations are necessary for a bull trout metapopulation to function effectively.

Recovery Units: Bull trout may be grouped so that they share genetic characteristics as well as management jurisdictions (See Dunham and Rieman 1999; Rieman and Allendorf 2001). Such groups have been classified as recovery units. They can range from one local population to multiple core areas. The recovery units identified in this plan are the units at which recovery efforts are specified and evaluated. As such, it was important to consider the genetic relationships between populations as well as how populations should be grouped to foster effective management. For example, most recovery units do not cross state boundaries nor do they include mainstem areas of the Snake or Columbia rivers. This grouping was designed to promote local management decisions concerning populations of bull trout that are demographically dependent. In addition, most recovery units are composed of multiple core areas and single or multiple recovery units compose a distinct population segment.

There are 27 bull trout recovery units (Table 1) in the coterminous United States (1 for the Klamath River, 22 for the Columbia River, 1 for the Jarbidge River, 2 for the Coastal-Puget Sound, and 1 for the St. Mary-Belly River distinct population segments).

For the purposes of bull trout recovery planning, abundance levels were conservatively evaluated at the local population and core area levels. Local populations that contained fewer than 100 spawning adults per year were classified at risk from inbreeding depression. Bull trout core areas that contained fewer than 1,000 spawning adults per year were classified as at risk from genetic drift. Further details and guidelines regarding these minimum population sizes are provided in the recovery plans for each recovery unit. In some instances these guidelines depart from the theoretical and reflect the judgment of the recovery unit teams based on current habitat limitations, appraisals of prospects for developing and achieving recovery criteria, and best available information.

Recovery Goals and Objectives

The goal of the bull trout recovery plan is to **ensure the long-term persistence of self-sustaining, complex interacting groups of bull trout distributed across the species native range so that the species can be delisted**. Recovery of bull trout will require reducing threats to the long-term persistence of populations, maintaining multiple interconnected populations of bull trout across the diverse habitats of their native range, and preserving the diversity of bull trout life-history strategies (*e.g.*, resident or migratory forms, emigration age, spawning frequency, local habitat adaptations). To accomplish this goal, the following four objectives have been identified:

- Maintain current distribution of bull trout within core areas as described in recovery unit chapters and restore distribution where recommended in recovery unit chapters.

- Maintain stable or increasing trends in abundance of bull trout. Abundance levels will be defined in individual recovery units.

- Restore and maintain suitable habitat conditions for all bull trout life history stages and strategies.

- Conserve genetic diversity and provide opportunity for genetic exchange.

Actions and tasks described in the recovery plan address these objectives, or generate information useful in refining and evaluating them.

Recovery Criteria

Recovery criteria for bull trout address quantitative measurements of bull trout distribution, population characteristics, and threats that are linked to recovery objectives. Recovery criteria are developed on a recovery unit basis. Criteria specific to each recovery unit are presented in each recovery unit chapter. Individual chapters may contain criteria for assessing the status of bull trout and alleviating threats that are unique to one or several recovery units. However, every chapter will contain criteria addressing the following characteristics:

- The distribution of bull trout in identified and potential local populations in all core areas within the recovery unit;

- The estimated abundance of adult bull trout within core areas in the recovery unit, expressed as either a point estimate or a range of individuals;

- The presence of stable or increasing trends for adult bull trout abundance in the recovery unit; and

- The restoration of passage at specific barriers identified as inhibiting recovery.

Criteria are established to gauge achievement of recovery objectives and assess whether actions have resulted in the recovery of bull trout. Recovery criteria reflect the stated objectives and consideration of population and habitat characteristics within the recovery unit. The current status of bull trout was evaluated based on four population elements. The four elements were: 1) number of local populations, 2) adult abundance (defined as the number of spawning fish present in a core area in a given year), 3) productivity, or the reproductive rate of the population (as measured by population trend and variability), and 4) connectivity (as represented by the migratory life history form and functional habitat). For each element, bull trout were classified based on relative risk categories.

These elements were derived from the best scientific information available concerning bull trout population and habitat requirements (Rieman and McIntyre 1993; Rieman and Allendorf 2001) (see also Appendix 4, Effective Population Size). Levels of adult abundance and the number of local populations needed to spread extinction risk should be viewed as a best estimate given limited information on bull trout. Based on the best data available and professional judgment, recovery unit teams then evaluated each element under a potential recovered condition. Evaluation of these elements under a recovered condition assumed that actions identified within this chapter had been implemented. This approach acknowledges that, even when recovered, the status of bull trout populations in some core areas may remain short of ideals described by conservation biology theory. Some core areas under recovered conditions may be limited by natural attributes or patch size, and may always remain at a relatively high risk of extirpation.

Number of Local Populations

Multiple local populations distributed and interconnected throughout a watershed provide a mechanism for spreading risk from stochastic events. Distribution of local populations in such a manner is, in part, an indicator of a functioning core area. Based in part on guidance from Rieman and McIntyre (1993), bull trout core areas with fewer than five local populations are at increased risk; core areas with between 5 to 10 local populations are at intermediate risk; and core areas which have more than 10 interconnected local populations are at diminished risk.

Some recovery units also use the term “potential” local populations in the number of local populations or distribution criteria. A potential local population is defined as a local population that does not currently exist, but which might exist and contribute to recovery in a known or suspected unoccupied area, if spawning and rearing habitat or connectivity is restored in that area.

Adult Abundance

Recovered abundance levels were evaluated by considering theoretical estimates of effective population size, historic census information, and the professional judgment of recovery unit team members. In general, effective population size is a theoretical concept that allows prediction of potential future losses of genetic variation within a population, due to small population sizes and genetic drift. For the purposes of bull trout recovery planning, abundance levels were conservatively evaluated at the local population and core area levels. Local populations that contained fewer than 100 spawning adults per year were classified at risk from inbreeding depression. Bull trout core areas that contained fewer than 1,000 spawning adults per year were classified as at risk from genetic drift.

Productivity

A stable or increasing population is a key criterion for recovery under the requirements of the Endangered Species Act. Measures of the trend of a population (the tendency to increase, decrease, or remain stable) include population growth rate or productivity. Estimates of population growth rate (*i.e.*, productivity over the entire life cycle) that indicate a population is consistently failing to replace itself, indicate increased extinction risk. Therefore, the reproductive rate should indicate the population is replacing itself, or growing.

Since estimates of the total population size are rarely available, the productivity or population growth rate is usually estimated from temporal trends in indices of abundance at a particular life stage. For example, redd counts are often used as an index of a spawning adult population. The direction and magnitude of a trend in the index can be used as a surrogate for the growth rate of the entire population. For instance, a downward trend in an abundance indicator may signal the need for increased protection, regardless of the actual size of the population.

The population growth rate is also an indicator of extinction probability. The probability of going extinct cannot be measured directly; it can, however, be estimated as the consequence of the population growth rate and the variability in that rate. For a population to be considered viable, its natural productivity should be sufficient to replace itself from generation to generation. Evaluations of population status will also have to take into account uncertainty in estimates of population growth rate or productivity. The growth rate must indicate a stable or increasing population for a period of time for the population to contribute to recovery.

Connectivity

The presence of the migratory life history form of bull trout was used as an indicator of the functional connectivity of the system. If the migratory life form was absent from a core area, or if the migratory form is present but local populations lack connectivity, the core area was considered to be at increased risk. If the migratory life form persists in at least some local populations, with partial ability to connect with other local populations, the core area was judged to be at intermediate risk. Finally, if the migratory life form was present in all, or nearly all, local populations, and had the ability to connect with other local populations, the core area was considered to be at diminished risk.

Distinct Population Segment Structure and Population Units

Population units of bull trout exist in which all fish share an evolutionary legacy and which are significant from an evolutionary perspective (Spruell *et al.* 1999). These population units can range from a local population to multiple recovery units and theoretically should represent a distinct population segment. Although such population units are difficult to characterize, genetic data have provided useful information on bull trout population structure. For example, genetic differences between the Klamath and Columbia river populations of bull trout were revealed in 1993 (Leary *et al.* 1993). Based largely on this 1993 information and the lack of additional information, the current distinct population segment structure of bull trout in the Klamath and Columbia rivers, Jarbidge River, St. Mary-Belly rivers and Coastal-Puget Sound was developed for the listings in 1998 and 1999.

Since the 1998 listing, genetic analyses have suggested that bull trout populations may be organized on a finer scale than previously thought. Additional genetic data has revealed genetic differences between coastal populations of bull trout, including the lower Columbia and Fraser rivers, and inland populations in the upper Columbia and Fraser river drainages, east of the Cascade and Coast mountains (Williams *et al.* 1997; Taylor *et al.* 1999). There is also an apparent genetic differentiation between inland populations within the Columbia River basin. This differentiation occurs between the (a) mid-Columbia (John Day, Umatilla) River and lower Snake River (Walla Walla, Clearwater, Grande Ronde, Imnaha rivers, etc) populations and the (b) upper Columbia River (Methow, Clark Fork, Flathead River, etc.) and upper Snake River (Boise River, Malheur River, Jarbidge River, etc.) populations (Spruell *et al.* 2000; Paul Spruell, University of Montana, pers. comm. 2002). Genetic data indicate bull trout inhabiting the Deschutes River drainage of Oregon are derived from coastal populations and not from inland populations in the Columbia River basin (Leary *et al.* 1993; Williams *et al.* 1997; Spruell and Allendorf 1997; Taylor *et al.* 1999; Spruell *et al.* 2000). In general, evidence since the time of listing suggests a need to further evaluate the distinct population segment structure of bull trout populations being considered in this recovery plan. (See further discussion in Bull Trout Recovery and Delisting.)

<u>The Role of Recovery Units in Survival and Recovery of Bull Trout</u>

Recovery units were designated to facilitate development of the recovery plan by placing the scope of bull trout recovery on smaller spatial scales than the larger distinct population segments. Focusing recovery on smaller areas is advantageous because bull trout are widely distributed, and their habitats and factors affecting them vary greatly throughout their distribution. Thus, a narrower scope allows recovery tasks to be tailored to specific areas and encourages implementation of tasks by local interests. Although biological and non-biological issues (*i.e.*, jurisdictional and logistical concerns) were considered in identifying the 27 recovery units, recovery units generally have a biological basis in that they are groupings of bull trout for with historical or current gene flow. Thus, isolated basins, major river basins, and collections of basins represent the boundaries of recovery units

Individual recovery units are important to bull trout recovery by providing for the distribution of bull trout across their native range and maintaining adaptive ability to ensure long-term persistence. Similarly, individual core areas are the foundation of recovery units, and maintenance of these areas is critical to recovery. Genetic diversity enhances long-term survival of a species by increasing the likelihood that the species is able to survive changing environmental conditions. For instance, a local population of bull trout may contain individuals with genes that enhance their ability to survive in the prevailing local environmental conditions. Individuals with a different genetic complement may persist in the local population in much lower abundance than those with locally adapted genes.

Each recovery unit is important; and recovery units are an appropriate scale at which to gauge progress toward recovery for individual distinct population segments and the species within the coterminous United States. Recovering bull trout in each recovery unit will maintain the overall distribution of bull trout in their native range. Conserving core areas and their habitats within recovery units should preserve genotypic and phenotypic diversity and allow bull trout access to diverse habitats. The continued survival and recovery of individual core areas is critical to the persistence of recovery units and their role in the recovery of a distinct population segment. Recovered conditions and tasks for core areas are described in recovery unit chapters.

<u>The Role of Artificial Propagation and Transplantation in Bull Trout Recovery</u>

Section 3(3) of the Endangered Species Act lists artificial propagation and transplantation as methods that may be used for the conservation of listed species. Hatcheries have played an important role in recovery efforts of other listed fish species (Rinne *et al.* 1986). The bull trout recovery plan recognizes that certain recovery units within the distinct population segment may require the use of artificial propagation techniques in order to meet recovery criteria. Artificial propagation could involve the transfer of bull trout into unoccupied habitats or could involve the use of Federal, State, or Tribal hatcheries to assist in recovery efforts (Buchanan *et al.* 1997; USFWS 1998e). The use of artificial propagation programs for bull trout must be authorized by the U.S. Fish and Wildlife Service and meet applicable State and Tribal fish-handling and disease policies.

The Montana Bull Trout Scientific Group evaluated seven strategies for the potential use of artificial propagation in the recovery of bull trout (MBTSG 1996g). The report evaluated the use of hatcheries in establishing genetic reserves, restoration stocking, research activities, supplementation programs, introductions to expand distribution, and the establishment of “put, grow, and take” fisheries. The report concluded that the potential use of hatcheries in bull trout recovery could include the establishment of genetic reserves for declining populations, restoration stocking, and some research activities including the evaluation of hybridization. However, the report concluded that the use of hatcheries for bull trout supplementation programs, “put, grow, and take” stocking, and introductions outside historic range were not appropriate. The bull trout recovery plan recommends that a study be initiated to determine the effectiveness and feasibility of using artificial propagation in bull trout recovery. Specific goals and objectives for the use of hatcheries in the recovery and conservation of bull trout should be identified. Information gained from this study will help guide proposed artificial propagation programs identified in individual recovery unit chapters.

Any artificial propagation program instituted for bull trout will follow the joint policy of the U.S. Fish and Wildlife Service and the National Marine Fisheries Service regarding controlled propagation of listed species (65 FR 56916). The overall guidance of the policy is that every effort should be made to recover a species in the wild before implementing an artificial propagation program. Because recovery for bull trout entails the identification and correction of threats affecting bull trout, artificial propagation programs should not be implemented until the reasons for decline have been addressed.

The Role of Fire and Aquatic Habitats in Bull Trout Recovery

Bull trout evolved under historic fire regimes, in which disturbance to streams from forest fires resulted in a mosaic of diverse habitats. However, forest management and fire suppression over the past century have increased homogeneity of terrestrial and aquatic habitats, increasing the likelihood of large, intense forest fires in some areas. Because the most severe effects of fire on native fish populations can be expected where populations have become fragmented by human activities or natural events, an effective strategy to ensure persistence of native fishes against the effects of large fires may be to restore aquatic habitat structure and life history complexity of populations in areas susceptible to large fires (Gresswell 1999).

Rieman and Clayton (1997) discussed relations among the effects of fire and timber harvest, aquatic habitats, and sensitive species. They noted that spatial diversity and complexity of aquatic habitats strongly influence the effects of large disturbances on salmonids. For example, Rieman, Lee, Chandler, and Myers (1997a) studied bull trout and redband trout responses to large, intense fires that burned three watersheds in the Boise National Forest in Idaho. Although the fires were the most intense on record, there was a mix of severely-to-unburned areas left after the fires. Fish were apparently eliminated in some stream reaches, whereas others contained relatively high densities of fish. Within a few years after the fires and after areas within the watersheds experienced debris flows, fish had become reestablished in many reaches, and densities increased. In some instances, fish densities were higher than those present before the fires or in streams that were not burned (Rieman, Lee, Chandler, and Myers 1997). These responses were attributed to spatial habitat diversity that supplied refuge areas for fish during the fires, and the ability of bull trout and redband trout to move among stream reaches. For bull trout, the presence of migratory fish within the system was also important (Rieman and Clayton 1997; Rieman, Lee, Chandler, and Myers 1997).

For bull trout recovery, the appropriate strategy to reduce the risk of fires on bull trout habitats is to emphasize the restoration of watershed processes that create and maintain habitat diversity, provide access to habitats, and protect or restore migratory life-history forms of bull trout. Both passive (*e.g.*, encouraging natural riparian vegetation and floodplain processes to function appropriately) and active (*e.g.*, reducing road density, removing barriers to fish movement, and improving habitat complexity) recovery actions offer the best approaches to protect bull trout from the effects of large fires.

The Role of the Mainstem Columbia and Snake Rivers

Historically, the mainstem Snake and Columbia rivers were likely used as migration corridors, foraging areas, and overwintering habitat by fluvial bull trout that originated in tributary streams throughout the basins. Presently, mainstem habitat may or may not be used by bull trout depending on the strength of their populations in tributary streams and the availability of migration corridors that connect to the Columbia and Snake rivers.

Bull trout have multiple life history strategies, including migratory forms, throughout their range (Rieman and McIntyre 1993). Migratory forms appear to develop when habitat conditions allow movement between spawning and rearing streams and larger rivers or lakes where foraging opportunities may be enhanced (Frissell 1993). For example, multiple life history forms (*e.g.*, resident and fluvial) and multiple migration patterns have been noted in the Grande Ronde River (Baxter 2002). Parts of this river system have retained habitat conditions that allow free movement between spawning and rearing areas and the mainstem Snake River. Such multiple life history strategies help to maintain the stability and persistence of bull trout populations to environmental changes. Benefits to migratory bull trout include greater growth in the more productive waters of larger streams and lakes, greater fecundity resulting in increased reproductive potential, and dispersing the population across space and time so that spawning streams may be recolonized should local populations suffer a catastrophic loss (Rieman and McIntyre 1993; MBTSG 1998; Frissell 1999;).

In the mid-Columbia River, bull trout have been observed passing the fish ladders at Wells, Rocky Reach, and Rock Island dams. Bull trout have also been observed in the fish ladder counting stations at Bonneville Dam in the lower Columbia River (Sprague, *in litt.* 2002). In the Snake River, bull trout have been observed in the fish ladder counting stations at Little Goose and Lower Monumental dams (Richards 2002) and at the juvenile fish collection facilities at Lower Granite, Little Goose, Lower Monumental, and Ice Harbor dams (Baxter 2002).

Bull trout use of the mainstem Columbia River has recently been documented by radio-tagging studies conducted by the U.S. Fish and Wildlife Service (Kelly-Ringel and DeLaVergne 2000, 2001) and the Chelan, Douglas, and Grant County public utility districts (Kreiter 2001, 2002). This information indicates that bull trout are likely foraging and/or overwintering throughout the mainstem Columbia River (Kreiter 2002; T. Dresser, Grant County Public Utilities District, pers. comm. 2002; D.Ward, ODFW, pers. comm., 2002; Oregon Department of Fish and Wildlife *in litt.* 2001; J. Wachtel, WFW, *in litt.* 2000).

Studies by the Oregon Department of Fish and Wildlife (Hemmingsen *et al.* 2001a, b) and Idaho Power Company (Chandler and Richter 2001) have verified movements of bull trout between tributary streams and the mainstem Snake River (Buchanan *et al.* 1997; J. Chandler, IPC, pers. comm. 2002.

Radio-tag studies have also shown evidence of bull trout movement between Pine and Indian creeks as well. One fish that was radio-tagged in Indian Creek was found to have moved to a tributary of the North Fork of Pine Creek (Chandler and Richter 2001). Chandler and Richter (2001) also reported that two bull trout that were radio-tagged in the reservoir moved into the Pine Creek system. One fish was tracked as far as the confluence of Lake Creek and North Pine Creek and then moved back to the reservoir. The other fish moved about 4.97 miles (8 kilometers) into Pine Creek before being lost to predation.

Restoring and maintaining connectivity between existing populations of bull trout is important for the persistence of the species (Rieman and McIntyre 1993), as well as providing for expression of the migratory life history form. Migration and occasional spawning between populations increases genetic variability and strengthens population variability (Rieman and McIntyre 1993).

In summary, foraging and migratory habitat are important to bull trout. Although currently fragmented by the presence of dams, the mainstem Columbia and Snake rivers provide habitat that potentially helps to maintain interactions between populations of bull trout in the tributaries, and provides for foraging and overwintering opportunities. Migratory corridors such as these allow individuals access to unoccupied but suitable habitats, foraging areas, and refuges from disturbances (Saunders *et al.* 1991). In the absence of the migratory bull trout life form, isolated populations cannot be replenished when disturbance makes local habitats temporarily unsuitable, the range of the species is diminished, and the potential for enhanced reproductive capabilities are lost (Rieman and McIntyre 1993). The relationship of the mainstem Snake and Columbia rivers to individual recovery units and the local populations within those units are discussed in the respective recovery unit chapters.

Recovery Monitoring and Evaluation

A key component of recovery planning is an effective monitoring and evaluation program. Monitoring involves systematic observation, detection, and recording of conditions, resources, and environmental effects of management programs and actions. It allows determination of trends in fish populations and how well the elements of the strategy are working, and enables the testing of key assumptions and resolution of important questions. Specific goals of bull trout monitoring include characterization of the status of recovery units by describing population abundance, trends in abundance, distribution of bull trout within core habitat, and connectivity. Accurate characterization of the status of bull trout populations, before and after implementation of recovery actions, enables estimation of the effectiveness of those actions. A description of work done to date on bull trout monitoring, and proposals for future approaches, is provided in the (Bull Trout Workshop Report *in litt.* 2002)

Monitoring and evaluation efforts can be divided into different categories, depending upon what kinds of questions are being addressed. *Baseline monitoring* is intended to depict the reference conditions in fish population abundance, trend, distribution, and habitat, from which a change that might be due to management activities could be detected. *Implementation monitoring* is aimed at determining whether strategy elements of a management plan are being implemented correctly. *Effectiveness monitoring* addresses the question of whether strategy elements and actions, having been implemented, are achieving their objectives. *Validation monitoring* is designed to explore key assumptions underlying conservation actions and strategies, by ascertaining cause-and-effect relationships.

It may be impractical to monitor the effectiveness of each and every recovery action, or the status of populations in every core area in every recovery unit, to the same extent. The health of populations and the quality of bull trout habitat will need to be inferred from indicators. Potential indicators include both biological and physical measures, which can be divided into five categories: (1) *Fish* – measures of abundance, distribution, genetic diversity, age structure, fecundity, etc., (2) *Physical (instream) habitat* – gravel size, channel morphology, etc., (3) *Water quantity* – minimum flows, seasonal response, etc., (4) *Water quality* – temperature, sediment, etc., and (5) *Land use/cover* – amount of vegetation in stream buffers, percentage of watershed covered by impervious surfaces, etc. Indicators may in some instances be identical to actual characteristics of interest; in other instances, they will be surrogates for key features, intended to provide a reasonable representation of the attribute of interest.

Efficient use of monitoring and recovery resources and effort will require adhering to the principles and procedures of adaptive management. Adaptive management is a science-based management approach, incorporating continuing review of how well actions are achieving their objectives. Adaptive management recognizes uncertainties are unavoidable and that action cannot wait for uncertainties to be eliminated. The approach seeks to find actions that maximize the ability to achieve conservation and recovery objectives, while facilitating learning about key uncertainties relevant to selecting long term management actions. Based on results of monitoring and evaluation efforts, it can help suggest what steps are necessary to increase chances for successful recovery. Over time, a better understanding of what is working and what is not should be gained, which ideally will lead to improvement in the quality and efficacy of management decisions and actions. The course of adaptive management can be encapsulated in a series of steps, which describe one of multiple iterations in the process (that is, after the last step, start again with step #1, incorporating the new data):

1. Identify what is known and unknown in the various recovery units (scientific foundation).

2. Identify strategies/key actions for implementation (conservation actions).

3. Identify the performance standards that need to be measured to determine population status and efficacy of conservation strategies.

4. Identify and prioritize key technical and policy questions related to the scientific foundation and conservation strategies.

5. Determine the most efficient allocation of resources (funding and personnel) to achieve conservation and information objectives, using chosen performance measures.

6. Design (or update) a detailed monitoring plan to meet the identified objectives, consistent with available resources.

7. Implement conservation strategy and monitoring plan.

Planning a regional monitoring program will require coordination and prioritization of diverse efforts by a number of different agencies. This involves several tasks, among them (1) inventorying and evaluating existing monitoring programs, (2) defining the ultimate objectives of bull trout monitoring and evaluation for all of the involved parties, (3) improving coordination between monitoring programs and responsible agencies, (4) addressing key design elements, such as sampling frame (where/when to measure), what to measure, and how to measure (protocol), and (5) coordinating efforts of recovery monitoring with those of other statutory requirements of the Endangered Species Act (*e.g.*, section 4d rules, section 7 consultations, habitat conservation plans).

To help direct and prioritize future monitoring efforts, and to maximize the amount of information useful to recovery planning garnered from current studies, the U.S. Fish and Wildlife Service will establish a Recovery Monitoring and Evaluation Technical Group. The Monitoring and Evaluation Technical Group will be a multi-agency body chaired by the U.S. Fish and Wildlife Service. Desirable skills of potential members include expertise in field studies, population dynamics, char biology, biometrics, and experimental design. Guidance and oversight will be provided by the U.S. Fish and Wildlife Service's Bull Trout Coordinator and the overall recovery team to the Monitoring and Evaluation Technical Group. General, ongoing objectives and tasks of the Monitoring and Evaluation Technical Group will include: (1) increase utility of current data collection for recovery planning, (2) guide and prioritize future studies, (3) summarize monitoring and evaluation needs of cooperators, (4) foster coordination among monitoring programs, (5) help develop and standardize design elements, and (6) review analytical methods of characterizing population and habitat status.

The advice and guidance of the Monitoring and Evaluation Technical Group will be formalized in reports. The reports may include reviews of specific monitoring proposals, summaries of the monitoring and evaluation needs of cooperators, recommendations of appropriate scale and protocols for various management questions, and critiques of analytical methods for estimating population status and monitoring effectiveness. Certain key products of the Monitoring and Evaluation Technical Group will also be subject to independent scientific review.

Bull Trout Recovery and Delisting Determinations

Achieving recovery objectives and making formal delisting decisions are two separate processes. Recovery occurs when threats to a species, or to a distinct population segment, have been removed, and the species is a secure, self-sustaining component of the ecosystem. The recovery criteria established in a recovery plan describe recovery conditions for a listed species in clear and measurable terms. Delisting is the subsequent regulatory rulemaking process that the U.S. Fish and Wildlife Service uses to remove the recovered species, or distinct population segment, from the list of threatened and endangered species, and therefore removing the protections that apply to listed species. A delisting determination must demonstrate that the species is no longer threatened or endangered, through an analysis of the five listing factors (destruction of habitat, over-utilization, disease or predation, inadequacy of existing regulatory protections, and other natural and man-made factors) set forth in the Endangered Species Act. A delisting determination can only be made on a "listable entity." Listable entities include species, subspecies, or distinct population segments of any species or vertebrate fish or wildlife that interbreeds when mature. Criteria for applying the definition of distinct population segment are found in the joint U.S. Fish and Wildlife Service and National Marine Fisheries Service "Policy Regarding the Recognition of Distinct Vertebrate Population Segments Under the Endangered Species Act" (61 FR 4722). Currently, the rules that listed the Klamath River, Columbia River, Jarbidge River, Coastal Puget-Sound, and St. Mary-Belly River bull trout as threatened, establish those populations as distinct population segments. Subsets of those populations would have to be shown to meet the definition of distinct population segment before the U.S. Fish and Wildlife Service could propose delisting those populations or groups of populations.

Consideration of interim regulatory relief may be provided for recovery units that meet their recovery criteria prior to recovery criteria being achieved in every unit in the overall distinct population segment through an exemption from take prohibitions for bull trout in that recovery unit through the special rulemaking process under section 4(d) of the Endangered Species Act. In that case, bull trout would remain listed as threatened in that recovery unit, but the prohibitions against take of bull trout would be removed through an exemption applying to that recovery unit.

We expect recovery of bull trout to be a dynamic process occurring over time. The recovery objectives are based on our current knowledge and may be refined as more information becomes available. The recovery team acknowledges that some local populations, and possibly core area populations, may be extirpated even though recovery actions are being implemented. Bull trout populations may be extirpated by naturally occurring events and factors due to human activities influencing populations (*e.g.*, habitat degradation, population fragmentation, and nonnative species introductions). Because recovery unit teams develop specific recovery criteria, they should consider extirpations on a case-by-case basis and forward recommendations to the recovery team. If reestablishment of recently extirpated populations is deemed infeasible or impractical by the recovery unit teams, then recovery criteria for a given recovery unit will be revised to reflect the current condition.

ACTIONS NEEDED TO INITIATE RECOVERY

Recovery for bull trout will entail reducing threats to the long-term persistence of populations and their habitats, ensuring the security of multiple interacting groups of bull trout, and providing habitat conditions and access to them that allow for the expression of various life-history forms. Specific tasks falling within the following seven categories will be necessary to initiate recovery across all recovery units:

- Protect, restore, and maintain suitable habitat conditions for bull trout.
- Prevent and reduce negative effects of nonnative fishes and other nonnative taxa on bull trout.
- Establish fisheries management goals and objectives compatible with bull trout recovery, and implement practices to achieve goals.
- Characterize, conserve, and monitor genetic diversity and gene flow among local populations of bull trout.
- Conduct research and monitoring to implement and evaluate bull trout recovery activities, consistent with an adaptive management approach using feedback from implemented, site-specific recovery tasks.
- Use all available conservation programs and regulations to protect and conserve bull trout and bull trout habitats.
- Assess the implementation of bull trout recovery by recovery units, and revise recovery unit plans based on evaluations.

Recovery Measures Narrative

In this chapter and all other chapters of the bull trout recovery plan, the recovery measures narrative consists of a hierarchical listing of actions that follow a standard template. The first-tier entries are identical in all chapters and represent general recovery tasks under which specific (*e.g.*, third-tier) tasks appear when appropriate. Second-tier entries also represent general recovery tasks under which specific tasks appear. Second-tier tasks that do not include specific third-tier actions are most often programmatic activities that are applicable across the species' range and appear in *italicized font*. These tasks are explained more fully in this chapter. Some second-tier tasks may not be sufficiently developed to apply to a particular recovery unit at this time and they appear in *an italicized shaded font (as seen here)*. These tasks are included to preserve consistency in numbering tasks among recovery unit chapters and intended to assist in generating information during the comment period for the draft recovery plan, a period during which additional tasks may be developed. Third-tier entries are tasks specific to recovery unit chapters. They appear in the implementation schedule that follows the narrative section and are identified by three numerals separated by periods.

The recovery plan should be updated as recovery tasks are accomplished, or revised as environmental conditions change, monitoring results become available, and adaptive management evaluations are conducted. The recovery team should meet annually to review annual monitoring reports and summaries, and make recommendations to the U.S. Fish and Wildlife Service.

1 **Protect, restore, and maintain suitable habitat conditions for bull trout.**

1.1 Maintain or improve water quality in bull trout core areas or potential core habitat.

1.2 Identify barriers or sites of entrainment for bull trout and implement tasks to provide passage and eliminate entrainment.

1.3 Identify impaired stream channel and riparian areas and implement tasks to restore their functions.

1.4 Operate dams to minimize negative effects on bull trout in reservoirs and downstream.

1.5 Identify upland conditions negatively affecting bull trout habitats and implement tasks to restore appropriate functions.

2 **Prevent and reduce negative effects of nonnative fishes and other nonnative taxa on bull trout.**

2.1 Develop, implement, and enforce public and private fish stocking policies to reduce stocking of nonnative fishes that affect bull trout.

Activities should include an evaluation of all fish stocking programs including public and private hatchery practices to minimize the risk of further introductions of nonnative species within the range of the bull trout and increased enforcement of fish policies to reduce the threat of inadvertent introductions from private fish ponds.

2.2 Evaluate enforcement policies for preventing illegal transport and introduction of nonnative fishes.

We encourage agencies to review their existing policies and the enforcement of those policies for illegal transport and introductions of nonnative species to ensure that the policies are effective protection of bull trout. Where these policies do not exist, we encourage development of policies to prevent illegal transport and introduction of nonnative species.

2.3 Provide educational opportunities to the public about ecosystem concerns of introductions of nonnative fishes.

A program should be implemented in each State to provide educational and outreach opportunities to the public about the problems and consequences of unauthorized fish introductions.

2.4 Evaluate biological, economic, and social effects of control of nonnative fishes.

This evaluation should provide recommendations and protocols for experimental removal or suppression of nonnative fishes in those areas where nonnative fishes may be adversely affecting bull trout.

2.5 Develop tasks to reduce negative effects of nonnative taxa on bull trout.

Steps to accomplish this task include conducting complete species composition surveys in targeted streams, evaluation of the level of competition of nonnative species on juvenile and subadult bull trout during the winter and summer months, and evaluation of the level of competition between nonnative species and bull trout prey species.

2.6 Implement control of nonnative fishes where found to be feasible and appropriate.

The abundance and distribution of nonnative game fishes may greatly affect bull trout survival and recruitment in a given year. Monitoring of nonnative fish populations should be implemented in conjunction with monitoring of bull trout populations (see task #5.1). Effectiveness monitoring of any control measures can be incorporated into an overall monitoring program for bull trout. Control measures can include experimental removal of nonnative species and targeted harvest of nonnatives through liberalized harvest regulations.

3 Establish fisheries management goals and objectives compatible with bull trout recovery, and implement practices to achieve goals.

3.1 Develop and implement State and Tribal native fish management plans integrating adaptive research.

3.2 Evaluate and prevent overharvest and incidental angling mortality of bull trout.

Bull trout are highly susceptible to angling. Steps should be taken to assess the existing and potential impacts of angling on bull trout populations, implement and monitor compliance with existing protective angling restrictions, and provide information to anglers about bull trout identification and special regulations.

3.3 Evaluate potential effects of nonnative fishes and associated sport fisheries on bull trout recovery and implement tasks to minimize negative effects on bull trout.

Efforts should be made to evaluate the level of predation and competition of bull trout with nonnative sport fish. Research needed include assessing impacts of competition for spawning gravels, effects of competition for prey, and levels of predation on and by nonnative species. Once these negative effects have been established, efforts should focus on measures designed to minimize the effects of predation and competition of nonnative species on bull trout.

3.4 Evaluate effects of existing and proposed sport fishing regulations on bull trout.

This task applies to states with the management authority to regulate sport fishing. The states, in cooperation with the U.S. Fish and Wildlife Service, should evaluate management proposals to allow carefully regulated harvest of bull trout where monitoring of the population status provides a clear record that a harvestable surplus can be maintained and that harvest will benefit, or at least not be detrimental to, recovery goals.

4 **Characterize, conserve, and monitor genetic diversity and gene flow among local populations of bull trout.**

4.1 Incorporate conservation of genetic and phenotypic attributes of bull trout into recovery and management plans.

Genetic analysis samples can be collected throughout the range of bull trout as part of an overall monitoring plan. (See the section on Recovery Monitoring and Evaluation for a more detailed discussion.) Local populations should be managed to maintain long-term viability of bull trout. Agencies and individuals should ensure that management practices and polices allow for the long-term viability of unique characteristics of bull trout local populations.

4.2 Maintain existing opportunities for gene flow among bull trout populations.

Where feasible or appropriate, increase the population size and distribution of existing local populations of bull trout to maintain or restore opportunity for gene flow within or between core areas. Methods to explore include, but are not limited to, removal or reduction of competing species and restoration of degraded habitat.

4.3 Develop genetic management plans and guidelines for appropriate use of transplantation and artificial propagation.

Some chapters call for possible transplantation and artificial propagation in order to meet recovery goals within the 25-year time frame (see the Coeur d'Alene (Chapter 15), Deschutes (Chapter 7), and Snake River Washington (Chapter 24) chapters for examples). It will be necessary to establish genetic reserve protocols and standards for initiating, conducting, and evaluating captive propagation programs. It may also be necessary to artificially propagate bull trout to preserve fish that are likely to be extirpated or to conduct research. Protocols will be needed to standardize the process and prevent detrimental effects on the donor population and captive fish, for determining when transplantation and artificial propagation is necessary, how to conduct these activities, and how to evaluate their effectiveness.

5 **Conduct research and monitoring to implement and evaluate bull trout recovery activities, consistent with an adaptive management approach using feedback from implemented, site-specific recovery tasks.**

5.1 Design and implement a standardized monitoring program to assess the effectiveness of recovery efforts affecting bull trout and their habitats.

For a complete discussion of monitoring, see the section in this chapter titled "Recovery Monitoring and Evaluation".

5.2 Conduct research that evaluates relationships among bull trout distribution and abundance, bull trout habitat, and recovery tasks.

The list of research needs below provides a few of the priority research projects that apply across the range of the species. The reader should bare in mind that this list is incomplete and additional research may be proposed in individual recovery units.

1) Evaluation of the effectiveness of habitat restoration techniques in restoring watershed function and bull trout cores and local populations. Land and resource management agencies should coordinate and monitor habitat restoration project with the local U.S. Fish and Wildlife Service Field Office. Habitat restoration techniques include, but are not limited to, enhancement and restoration of riparian corridors (fencing for livestock management, stream bank erosion control, alternative water sources, etc.); instream habitat restoration (large woody debris, pool size and frequency, spawning substrate, etc.); upland/forest restoration (restoration of historic contours, native plant restoration and nonnative plant control, prescribed burns, thinning, replanting, etc.); and erosion control (stream bank contouring, fiber matting, vegetation, livestock control, road maintenance and/or decommission, etc.).

2) Determine the suitability of temperature regimes in currently occupied and potentially restorable bull trout drainages.

3) Assess current and historic effects of upland management on changes to the hydrograph. Activities in upland areas such as logging, road building, and grazing have affected hydrograph regimes in bull trout watersheds. The effects of these activities include changes in the timing and magnitude of peak flows.

4) Delineation of migratory habitat in recovery units and in the mainstem Columbia and Snake Rivers. See also the discussion in Columbia and Snake River Mainstem section.

5) Evaluation of temperature as a limiting factor. For bull trout to reach recovery goals it will be necessary to evaluate the role of seasonally elevated water temperatures as a limiting factor to juvenile bull trout rearing and/or adult migration.

6) Surveys to identify suitable unoccupied habitat for bull trout. These efforts should also include development of a comprehensive list of barriers that may be blocking access to suitable habitat by upstream migrating bull trout.

5.3 Conduct evaluations of the adequacy and effectiveness of current and past best management practices in maintaining or achieving habitat conditions conducive to bull trout recovery.

These evaluations can be conducted in conjunction with the overall monitoring effort discussed in the Recovery Monitoring and Evaluation section of this chapter. Best management practices can include those activities associated with water diversion structures and fish screens and livestock grazing and riparian management.

5.4 Evaluate effects of diseases and parasites on bull trout, and develop and implement strategies to minimize negative effects.

5.5 Develop and conduct research and monitoring studies to improve information concerning the distribution and status of bull trout.

Actions associated with this task can include regular presence/absence surveys for each recovery unit. These surveys will be based on the recommendations from the Recovery Monitoring and Evaluation Technical Team discussed in the Recovery Monitoring and Evaluation section.

5.6 Identify evaluations needed to improve understanding of relationships among genetic characteristics, phenotypic traits, and local populations of bull trout.

In addition to research proposals associated with task 5.2 and monitoring, as discussed in the Recovery Monitoring and Evaluation section, it will be important to fully understand the habitat requirements of resident and migratory bull trout populations. This should include assessing the ability and prevalence of resident bull trout to express migratory behavior and determining the habitat characteristics necessary for the migratory life history strategy. Additional information needed includes the annual abundance of breeding adults in a local population and the total breeding adult population for a recovery unit, the population structure and connectivity, life history characteristics including age at first spawning, incidence, regularity and timing of repeat spawning, and total life span, reproductive success in production of pre-adult offspring, survival rate to breeding adults, and reproductive success in replacement breeding individuals. There should also be an effort to investigate the transitional mechanisms between resident and migratory life history forms and an assessment of the threat due to hybridization with brook trout.

6 **Use all available conservation programs and regulations to protect and conserve bull trout and bull trout habitats.**

6.1 Use partnerships and collaborative processes to protect, maintain, and restore functioning core areas for bull trout.

Efforts can include providing technical assistance to private landowners on management of riparian areas, promoting land use planning and management that discourages the development of floodplains, promoting development of land and water management plans that minimize activities that impact bull trout habitat, inventory and promotion of groundwater inflow to key stream reaches for bull trout, and promoting, and assisting, collaborative efforts with local watershed working groups in developing and accomplishing site-specific protection and restoration activities. A necessary element to the success of any of the recovery actions discussed here will be to secure adequate funding and cooperation among interested and affected parties.

6.2 Use existing Federal authorities to conserve and restore bull trout.

Federal agencies should ensure continued compliance with the provisions of section 7 of the Endangered Species Act. Federal, State and private scientific research must also comply with provision under section 10 and states should continue to implement programs, in cooperation with the U.S.

Fish and Wildlife Service, under section 6. Efforts should be made to identify and develop opportunities for collaboration between the Clean Water Act and total maximum daily load planning and bull trout recovery planning and implementation.

6.3 Enforce existing Federal, State, and Tribal habitat protection standards and regulations and evaluate their effectiveness for bull trout conservation.

All existing regulations that may benefit bull trout should be evaluated and fully implemented. These regulations include State habitat protection laws, forest practices laws, lake protection laws, water quality standards, floodplain protection, and emergency flood repair guidelines.

7 **Assess the implementation of bull trout recovery by recovery units, and revise recovery unit plans based on evaluations.**

7.1 Convene annual meetings of each recovery unit team to review progress on recovery plan implementation.

7.1.1 Generate progress reports on implementation of the bull trout recovery plan in each recovery unit.

Annual reviews are necessary to track progress in implementing the recovery plan. Annual reports can be used to identify successful approaches for implementing recovery tasks and direct where efforts should be placed within recovery units.

7.2 Assess effectiveness of recovery efforts.

7.2.1 Develop and implement a standardized monitoring program to evaluate the effectiveness of recovery efforts (coordinate with recovery task 5.1).

A standardized monitoring program is needed to evaluate achievement of recovery objectives and provide information to adaptively manage and improve recovery efforts. See discussion in Recovery Monitoring and Evaluation.

7.3 Revise scope of recovery as suggested by new information.

IMPLEMENTATION SCHEDULE

Implementation schedules are contained in each recovery unit chapter. These schedules describe recovery task priorities, task numbers, task descriptions, duration of tasks, potential or participating responsible parties, estimated costs, and comments. Implementation tasks in recovery unit chapters 2 through 28, should lead to recovery of bull trout in the coterminous United States as discussed in Part II of this recovery plan.

Parties with authority, responsibility, or expressed interest to implement a specific recovery task are identified in the implementation schedule. Listing a responsible party does not imply that prior approval has been given, nor does it require that party to participate or expend funds. However, willing participants will benefit by demonstrating that their budget submission or funding request is for a recovery task identified in an approved recovery plan, and is therefore part of a coordinated effort to recover bull trout. In addition, section 7(a)(1) of the Endangered Species Act directs all Federal agencies to use their authorities to further the purposes of the Endangered Species Act by implementing programs for the conservation of threatened or endangered species.

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APPENDIX 1. GLOSSARY

Adaptive trait
Characteristics that improve an individual's survival and fitness.

Adfluvial bull trout
Bull trout that migrate from tributary streams to a lake or reservoir to mature (one of three bull trout life histories). Adfluvial bull trout return to a tributary to spawn.

Age at emigration
The age at which juvenile fish migrate from a tributary into a larger river or lake to complete growth into adults.

Age class
A group of individuals of a species that have the same age, *e.g.*, 1 year old, 2 year old, etc.

Aggrading stream
A stream that is actively building up its channel or floodplain by being supplied with more bedload than it is capable of transporting.

Alluvial
Pertaining to or composed of silts and clays (usually) deposited by a stream or flowing water. Alluvial deposits may occur after a flood event.

Alluvial fan
A sedimentary deposit located at a topographic break such as the base of a mountain front, escarpment, or valley side, that is composed of streamflow and/or debris flow sediments and that has the shape of a fan, either fully or partially extended.

Anadromous (fish)
A fish that is born in fresh water, migrates to the ocean to grow and live as an adult, and then returns to freshwater to spawn (reproduce).

Artificial propagation
The use of artificial procedures to spawn adult fish and raise the resulting progeny in fresh water for release into the natural environment, either directly from the hatchery or by transfer into another area.

Bedload
Sediment particles that are moved on or immediately above the stream bed, such as the larger heavier particles (gravel, boulders) rolled along the bottom; the part of the load that is not continuously in suspension.

Braided stream
A stream that forms an interlacing network of branching and recombining channels separated by islands and channel bars. Generally a sign of stream disequilibrium resulting from transportation of excessive rock and sediment from upstream areas and characteristic of an aggrading stream in a wide channel on a floodplain.

Bypass system (fish)
Structure in a dam that provides a route for fish to move through or around a dam without going through the turbines.

Canopy cover (of a stream)
Vegetation projecting over a stream, including crown cover (generally more that 1 meter (3.3 feet) above the water surface) and overhang cover (less than 1 meter (.3 feet) above the water).

Carrying capacity (fish)
Refers to the maximum average number of fish that can be sustained in a habitat over the long term.

Channel morphology
The physical dimension, shape, form, pattern, profile, and structure of a stream channel.

Channel stability
The ability of a stream, over time and in the present climate, to transport the sediment and flows produced by its watershed in such a manner that the stream maintains its dimension, pattern, and profile without either aggrading or degrading.

Channelization
The straightening and deepening of a stream channel to permit the water to move faster, to reduce flooding, or to drain wetlands.

Char
A fish belonging to the genus *Salvelinus* and related to both the trout and salmon. The bull trout, Dolly Varden trout, and the Mackinaw trout (or lake trout) are all members of the char family. Char live in the icy waters (both fresh and marine) of North America and Europe.

Complex interacting groups
Multiple local populations that may have overlapping spawning and rearing areas within a geographic area.

Core area
The combination of core habitat (*i.e.*, habitat that could supply all elements for the long-term security of bull trout) and a core population (a group of one or more local bull trout populations that exist within core habitat) constitutes the basic unit on which to gauge recovery within a recovery unit. Core areas require both habitat and bull trout to function, and the number (replication) and characteristics of local populations inhabiting a core area provide a relative indication of the core area's likelihood to persist. A core area represents the closest approximation of a biologically functioning unit for bull trout.

Core habitat
Habitat that encompasses spawning and rearing habitat (resident populations), with the addition of foraging, migrating, and overwintering habitat if the population includes migratory fish. Core habitat is defined as habitat that contains, or if restored would contain, all of the essential physical elements to provide for the security of and allow for the full expression of life history forms of one or more local populations of bull trout. Core habitat may include currently unoccupied habitat if that habitat contains essential elements for bull trout to persist or is deemed critical to recovery.

Core population
A group of one or more bull trout local populations that exist within core habitat.

Distinct population segment
The U.S. Fish and Wildlife Service has formally determined there are five bull trout distinct population segments across the species range within the coterminous United States--Klamath River, Columbia River, Jarbidge River, Coastal-Puget Sound, and St. Mary-Belly River. Each meets the tests of discreteness and significance under joint policy of the U.S. Fish and Wildlife Service and National Marine Fisheries Service (61 FR 4722), and these are the units against which
recovery progress and delisting decisions will be measured. A listable entity under the Endangered Species Act that meets tests of discreteness and significant according to U.S. Fish and Wildlife Service policy.

Deposition (stream)
The settlement or accumulation of material out of the water column and onto the stream bed. Occurs when the energy of flowing water is unable to support the load of suspended sediment.

Depositional areas (stream)
Local zones within a stream where the energy of flowing water is reduced and suspended material settles out, accumulating on the streambed.

Discharge (stream)
With reference to stream flow, the quantity of water that passes a given point in a measured unit of time, such as cubic meters per second or, often, cubic feet per second.

Effective population size
The number of breeding individuals that would give rise to the same amount of random genetic drift as the actual population, if ideal conditions held.

Embeddedness
The degree to which large particles (boulders, gravel) are surrounded or covered by fine sediment, usually measured in classes according to percentage covered.

Entrainment
Process by which aquatic organisms are pulled through a diversion, turbine, spillway, or other device.

Extirpation
The elimination of a species from a particular local area.

Fine sediment (fines)
Sediment with particle sizes of 2.0 mm (.08 inch) or less, including sand, silt, and clay.

Fish ladder
A device to help fish swim around a dam.

Floodplain
Adjacent to stream channels, areas that are typified by flat ground and are periodically submerged by floodwater.

Flow regime
The quantity, frequency and seasonal nature of water flow.

Fluvial bull trout
Bull trout that migrate from tributary streams to larger rivers to mature (one of three bull trout life histories). Fluvial bull trout migrate to tributaries to spawn.

Foraging, migrating, and overwintering habitat (bull trout)
Relatively large streams and mainstem rivers, including lakes or reservoirs, estuaries, and nearshore environments, where subadult and adult migratory bull trout forage, migrate, mature, or overwinter. This habitat is typically downstream from spawning and rearing habitat and contains all the physical elements to meet critical overwintering, spawning migration, and subadult and adult rearing needs. Although use of foraging, migrating, and overwintering habitat by bull trout may be seasonal or very brief (as in some migratory corridors), it is a critical habitat component.

Functionally extirpated
Describes a species that has been extirpated from an area; though a few individuals may occasionally be found, they are not thought to constitute a viable population.

Genotype
The set of alleles (variants of a gene) possessed by an individual at a particular locus or set of loci.

Habitat connectivity (stream)
Suitable stream conditions that allow fish and other aquatic organisms to move freely upstream and downstream. Habitat linkages that connect to other habitat areas.

Headwaters
The source of a stream. Headwater streams are the small swales, creeks, and streams that are the origin of most rivers. These small streams join together to form larger streams and rivers or run directly into larger streams and lakes.

Hooking mortality
Death of a fish from stress or injury after it is hooked and reeled in, then released back to the water.

Hybridization
Any crossing of individuals of different genetic composition, typically different species, that result in hybrid offspring.

Hydraulic residence time
The average period of time required to completely renew a lake's water volume.

Hydrologic response
The response of a watershed to precipitation; usually refers to streamflow resulting from precipitation.

Hydrologic unit (code)
Watersheds that are classified into four types of units: regions, subregions, accounting units, and cataloging. The units from the smallest (cataloging units) to the largest (regions). Each unit is identified by a unique hydrologic unit code consisting of two to eight digits based on the four levels of classification in the hydrologic unit system.

Hypolimnetic
Referring to the cold, lower-most layer of water in a thermally stratified lake or reservoir. The hypolimnion is the layer of water below the thermocline (metalimnion).

Hyporheic zone
Area of saturated sediment and gravel beneath and beside streams and rivers where groundwater and surface water mix. Water movement is mainly in a downstream direction**.**

Intermittent stream
A stream that flows only at certain times of the year as when it receives water from springs (or by surface water) or when water losses from evaporation or seepage exceed the available streamflow.

Interspecific competition
Competition for resources between two or more different species.

Introgression (genetic)
The spread of genes of one species into the gene pool of another by hybridization or by backcrossing (interbreeding between hybrid and parental species).

Legacy effects
Impacts from past activities (usually a land use) that continue to affect a stream or watershed in the present day.

Local population
A group of bull trout that spawn within a particular stream or portion of a stream system. Multiple local populations may exist within a core area. A local population is considered to be the smallest group of fish that is known to represent an interacting reproductive unit. For most waters where specific information is lacking, a local population may be represented by a single headwater tributary or complex of headwater tributaries. Gene flow may occur between local populations (*e.g.*, those within a core population), but is assumed to be infrequent compared with that among individuals within a local population.

Mass wasting
Loss of large amounts of material in a short period of time, *i.e.,* downward movement of land mass material or landslide.

Metapopulation
A group of semi-isolated subpopulations of bull trout that are interconnected and that probably share genetic material.

Migratory corridor (bull trout)
Stream reaches used by bull trout to move between habitats. A section of river or stream used by fish to access upstream spawning areas or downstream lake environments.

Migratory life history form (bull trout)
Bull trout that migrate from spawning and rearing habitat to lakes, reservoirs, or larger rivers to grow and mature.

Nonnative species
Species not indigenous to an area, such as brook trout in the western United States.

Peak flow (stream)
Greatest stream discharge recorded over a specified period of time, usually a year, but often a season.

Penstock
In a hydropower dam, the pipe that carries water from an upstream reservoir or pond downstream to the turbine generator in a power house.

Phenotype
Expressed physical, physiological, and behavioral characteristics of an organism that may be due to genetics, the environment, or an interaction of both.

Piscivorous
Describes fish that prey on other fish for food.

Potential local population
A local population that does not currently exist, but that could exist, if spawning and rearing habitat or connectivity were restored in that area, and contribute to recovery in a known or suspected unoccupied area.

Probability of persistence
The probability (usually expressed as a percentage) that a population or subpopulation of fish will survive and be present in a specific geographic location through some future time period, usually 100 years.

Recovery subunit (bull trout)
Portions of larger recovery units treated separately to improve management efficiency. For example, the Clark Fork Recovery Unit is divided into Upper Clark Fork, Lower Clark Fork, Priest, and Flathead recovery subunits.

Recovery team (bull trout)
A team of biologists from fish and wildlife resource agencies in Idaho, Montana, Oregon, and Washington, Native American Tribes, and the U.S. Fish and Wildlife Service responsible for providing guidance in developing the bull trout recovery plan.

Recovery unit (bull trout)
Recovery units are the major units for managing recovery efforts; each recovery unit is described in a separate chapter in the recovery plan. A distinct population segment may include one or several recovery units. Most recovery units consist of one or more major river basins. Several factors were considered in our identifying recovery units, for example, biological and genetic factors, political boundaries, and ongoing conservation efforts. In some instances, recovery unit boundaries were modified to maximize efficiency of established watershed groups, encompass areas of common threats, or accommodate other logistic concerns. Recovery units may include portions of mainstem rivers (*e.g.*, Columbia and Snake rivers) when biological evidence warrants inclusion. Biologically, recovery units are considered groupings of bull trout for which gene flow was historically or is currently possible.

Recovery unit team (bull trout)
A team of people with technical expertise in various aspects of bull trout biology from Federal and State agencies, Tribes, private industry, and interest groups responsible for assisting in developing one or more chapter(s) of the bull trout recovery plan for a given recovery unit.

Recruitment
The successful addition through birth and death of new individuals (fish) to a specific population.

Redd
A nest constructed by female fish of salmonid species in streambed gravels where eggs are deposited and fertilization occurs. Redds can usually be distinguished in the streambed gravel by a cleared depression, and an associated mound of gravel directly downstream.

Refounding
Reestablishment of a species into previously occupied habitat.

Resident life history form (bull trout)
Bull trout that do not migrate, but that reside in tributary streams their entire lives (one of three bull trout life cycles).

Riparian area
Area with distinctive soils and vegetation between a stream or other body of water and the adjacent upland. It includes wetlands and those portions of floodplains and valley bottoms that support riparian vegetation.

Salmonid
Fish of the family Salmonidae, including trout, salmon, chars, grayling, and whitefish. In general usage, the term most often refers to salmon, trout, and chars.

Scour
Concentrated erosive action by stream water, as on the outside curve of a bend; also, a place in a streambed swept clear by a swift current.

Smolt
A juvenile salmon or steelhead migrating to the ocean and undergoing physiological changes to adapt its body from a freshwater environment to a saltwater environment.

Source population
Strong subpopulations (*i.e.*, bull trout) that are within a metapopulation and that contribute to other subpopulations and reduce the risk of local extinctions.

Spawning and rearing habitat (bull trout)
Stream reaches and the associated watershed areas that provide all habitat components necessary for spawning and juvenile rearing for a local bull trout population. Spawning and rearing habitat generally supports multiple year classes of juveniles of resident or migratory fish and may also support subadults and adults from local populations of resident bull trout.

Spawning escapement
The number of adult fish from a specific population that survive spawning migrations and enter spawning grounds.

Spillway
The part of a dam that allows high water to flow (spill) over the dam.

Stochastic
The term is used to describe natural events or processed that are random. Examples include environmental conditions such as rainfall, runoff, and storms, or life-cycle events, such as survival or fecundity rates.

Stock
The fish spawning in a particular lake or stream(s) at a particular season, which to a substantial degree do not interbreed with any group spawning in a different place, or in the same place at a different season. A group of fish belonging to the same population, spawning in a particular stream in a particular season.

Storage reservoir
An artificial storage place for water, from which the water may be withdrawn for irrigation, municipal water supply, or flood control.

Subpopulation (bull trout)
A reproductively isolated group of bull trout spawning within a particular area of a river system; the basic unit of analysis used in listing bull trout, but not used extensively in the recovery plan.

Subwatershed
Topographic perimeter of the catchment area of a stream tributary.

Suspended load (washload)
The part of the total stream load that is carried for a considerable period of time in suspension, free from contact with the stream bed, it consists mainly of silt, clay, and sand.

Suspended sediment
Solids, either organic or inorganic, found in the water column of a stream or lake. Sources of suspended sediment may be either human induced, natural, or both.

Suspended yield
The amount of sediment carried in the water column of a stream and discharged past a point in the watershed during any given time period, usually expressed in kilograms per day.

Take
Activities that harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect; or attempt to engage in any such conduct to a listed (Endangered Species Act) species.

Thermocline
In the summer, the layer of water in a lake which exhibits the greatest unit decrease in temperature per unit increase in depth; the transitional zone between the upper, warmer layer of water (epilimnion) and the cooler, denser, lower layer (hypolimnion) of water.

Transplantation
Moving wild fish from one stream system to another without the use of artificial propagation.

Trophic status
Referring to the nourishment status or biological productivity of a water body; determined largely by nutrient concentrations (*i.e.*, phosphorous and nitrogen) and the resultant synthesis of organic compounds by green plants in the presence of these nutrients and light energy.

Water right
Any vested or appropriation right under which a person may lawfully divert and use water. It is a real property right appurtenant to and severable from the land on or in connection with which the water is used; such water right passes as an appurtenance with a conveyance of the land by deed, lease, mortgage, will, or inheritance.

Water yield (basin yield)
The quantity of water available from a stream at a given point over a specified duration of time.

Watershed
The area of land from which rainfall (and/or snow melt) drains into a stream or other water body. Watersheds are also sometimes referred to as drainage basins or drainage areas. Ridges of higher ground generally form the boundaries between watersheds. At these boundaries, rain falling on one side flows toward the low point of one watershed, while rain falling on the other side of the boundary flows toward the low point of a different watershed.

Woody debris
Woody material such as trees and shrubs; includes all parts of a tree such as root system, bowl, and limbs. Large woody debris refers to the woody material whose smallest diameter is greater than 10 centimeters, and whose length is greater than 1 meter.

Year class (cohort)
Fish in a stock born in the same year. For example, the 1987 year class of bull trout includes all bull trout born in 1987, which would be age 1 in 1988. Occasionally, a stock produces a very small or very large year class which can be pivotal in determining stock abundance in later years.

APPENDIX 2: BULL TROUT PROTECTION AND RECOVERY GUIDANCE FOR FEDERAL LANDS

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Introduction:

A large proportion of bull trout core habitats in recovery units occur on lands managed by the Federal government, including the Forest Service and Bureau of Land Management. Federal land management actions will have great opportunity and carry much of the responsibility to protect and recover bull trout. The listing rules (63 FR 13647; 64 FR 17110; 64 FR 58910) identified threats from past and existing Federal land management. These recommendations address those threats. Federal land managers should apply these recommendations where Federal lands overlap with recovery units in addition to existing or interim plans to alleviate threats and restore bull trout habitat on Federal lands.

These recommendations acknowledge the substantial contributions that the Forest Service and the Bureau of Land Management will need to make, and recognize their conservation advancements of the last several years. This recognition is apparent by the incorporation of Forest Service and Bureau of Land Management management direction of the Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl Standards and Guidelines for Management of Late-Successional and Old-Growth Forests Related Species Within the Range of the Northern Spotted Owl (Northwest Forest Plan), Interim Strategy for Managing Anadromous Fish-producing Watersheds in Eastern Oregon and Washington, Idaho, and Portions of California (PACFISH) and the Interim Strategy for Managing (resident) Fish-producing Watersheds in Eastern Oregon and Washington, Idaho, Western Montana, and Portions of Nevada (INFISH) into these recommendations for bull trout conservation on Federal lands.

Please note, some Forest Service and Bureau of Land Management administrative units have existing management direction that may be more protective than some of these recommendations. Such protective measures may have resulted from actions implemented to benefit other threatened, endangered or sensitive species, such as northern spotted owl, salmon, and grizzly bear, or specific standards for aquatic habitat management. These recommendations do not supercede existing management direction where it is more protective, such as in proposed Wilderness or Wild and Scenic River designations. In addition, Northwest Forest Plan, PACFISH, and INFISH direction provide management protection similar to these recommendations. These recommendations do not conflict with Northwest Forest Plan, INFISH, or PACFISH direction or the U.S. Fish and Wildlife Service's biological opinions regarding those plans and should be used to supplement Forest Service and Bureau of Land Management plans and our past biological opinions on these plans.

As part of the U.S. Fish and Wildlife Service's role in recovering bull trout, we will apply these recommendations during section 7 consultations with the Forest Service, Bureau of Land Management, and other Federal agencies to help design future actions consistent with bull trout recovery needs and as a standard for comparison of individual or groups of actions within watersheds.

Management Approach to Bull Trout Conservation on Federal Lands:

We recommend that Federal agencies follow these five components, listed and then described in detail below, when planning, designing, and implementing management actions within bull trout recovery units. Federal land management agencies should also consider these five components when analyzing potential effects of their plans or actions on bull trout.

1. Support recovery plan goals and objectives to maintain and restore bull trout habitats as described in the recovery plan and recovery unit chapters by implementing recovery tasks.

2. Identify and protect bull trout habitat protection zones.

3. Follow project designs for bull trout conservation.

4. Conduct watershed analysis and subbasin analysis and use results to design management plans and actions compatible with bull trout protection and recovery.

5. Use implementation and effectiveness monitoring to determine if:
    a) actions on federally managed lands implemented recovery tasks or followed the Project Designs for Bull Trout Conservation; and

    b) recovery tasks or Project Designs for Bull Trout Conservation successfully protect and contribute to the recovery of bull trout.

Below, each of the five components of the Management Approach is described in detail.

1. Support recovery plan goals and objectives to maintain and restore bull trout habitats as described in the recovery plan and recovery unit chapters by implementing recovery tasks.

The recovery plan identifies a single goal and four objectives (both programmatically and for individual recovery units), and describes general and specific tasks in the recovery unit chapters. Federal land managers should examine these and other parts of the recovery plan to determine how the information applies in their management unit(s), and to assure proposed actions are consistent and compatible with the tasks identified for particular areas. Especially where recovery unit chapters are not yet available, Federal lands should be managed according to the Interagency Implementation Team Interim Watershed Restoration Strategy (USDA *et al.* 2000a) and the Bull Trout Interim Guidance (USFWS 1998c), as appropriate. In general, management should maintain or improve the following conditions adapted from established aquatic conservation strategies in PACFISH, INFISH, and the Northwest Forest Plan:

(A) water quality to provide stable and productive riparian and aquatic ecosystems;

(B) stream channel integrity, channel processes, and the sediment regime (including the elements of timing, volume, and character of sediment input and transport) under which the riparian and aquatic ecosystems evolved;

(C) instream flows sufficient to restore riparian and aquatic habitats necessary for effective functions of stream channels, including discharge of flood waters;

(D) natural timing and variability of the water table elevation in meadows and wetlands;

(E) diversity and productivity of plant communities in riparian zones;

(F) riparian vegetation adequate to:

(1) provide a natural range of levels and distributions of large woody debris in streams and riparian areas;

(2) provide natural thermal regulation in riparian and aquatic habitats during summer and winter; and

(3) restore rates of surface erosion, bank erosion, and channel migration characteristic of those under which the communities evolved.

(G) riparian and aquatic habitats necessary to foster the unique genetic fish stocks that evolved within the specific physiographic setting; and

(H) connected habitats to support populations of well-distributed native and desired non-native plant, vertebrate, and invertebrate populations that contribute to the viability of riparian-dependent communities and protection and recovery of bull trout.

The specific, measurable habitat conditions or variables where bull trout thrive are described in the Interim Guidance (USFWS 1998c) as "biological needs" related to temperature, habitat complexity, connectivity, and substrate composition and stability, and that terminology is used here. For complete discussion of the terminology, please refer to Chapter 1 of the recovery plan and the Interim Guidance.

2. Identify and Protect Bull Trout Habitat Protection Zones

To protect and recover bull trout, lands with the most influence on streams must be managed primarily for bull trout and the riparian-dependent resources that bull trout depend upon. Management activities should use Project Designs for Bull Trout Conservation to protect these areas. For this document, we will call the areas with the most influence on streams "bull trout habitat protection zones."

Habitat protection zones have two main components:

2. A) Riparian-associated habitat protection zones that consist of riparian corridors, wetlands, intermittent streams, and other areas that help maintain the integrity of aquatic ecosystems by:

(1) influencing the delivery of coarse sediment, organic matter, and woody debris to streams;

(2) providing root strength for channel stability;

(3) providing thermal insulation in all seasons to streams; and

(4) protecting water quality (Naiman 1992); and

2. B) Roadless and low-density roaded habitat protection zones important for bull trout identified in the Road Density Analysis Task Team Report (USDA *et al.* 2000a).

In this document, habitat protection zones will be used to refer to both the riparian and roadless and low density roaded area habitat protection zones. Specific definitions for locating habitat protection zones on the landscape are described below.

Riparian associated habitat protection zones: Generally, the widths of riparian habitat protection zones that are adequate to protect streams from non-channelized sediment inputs should be sufficient to provide other riparian functions, including delivery of organic matter and woody debris, stream shading, and bank stability (Brazier and Brown 1973; Steinblums *et al.* 1984; Beschta *et al.* 1987; McDade *et al.* 1990; Sedell and Beschta 1991; Henjum *et al.* 1994; Belt *et al.* 1992). The effectiveness of riparian conservation areas in influencing sediment delivery from non-channelized flow is highly variable. One review of available scientific literature concluded that non-channelized sediment flow rarely travels more than 300 feet and that 200 to 300 foot riparian "filter strips" are generally effective at protecting streams from sediment from non-channelized flow (Belt *et al.* 1992). The riparian associated areas of habitat protection zones are very similar to the protected riparian areas in the Idaho Conservation Strategy (IDFG 1995). The references in this paragraph are the basis of the riparian habitat protection zones description below.

Riparian habitat protection zone widths should be applied where watershed analyses have not been completed, and wherever watershed analysis corroborates these recommended widths. Where watershed analysis indicates the riparian habitat protection zone width should be greater than those described here, those values should be applied. Watershed analysis information would be necessary to provide scientific rationale to justify modifications that would decrease riparian habitat protection zones within a specific area of a watershed.

The recommended description and measurements of riparian habitat protection zones fall into three categories of stream or water bodies as similarly described in the PACFISH, INFISH, and Northwest Forest Plan.

Perennial or historically perennial streams: Riparian habitat protection zones consist of the stream and the area on either side of the stream extending from the edges of the active stream channel to the top of the inner gorge, or to the outer edges of the 100-year floodplain, or to the outer edges of riparian vegetation, or to a distance equal to the height of two site-potential trees, or 300 feet slope distance (600 feet, including both sides of the stream channel), whichever is greater.

Ponds, lakes, reservoirs, and wetlands greater than 1 acre: Riparian habitat protection zones consist of the body of water or wetland and the area to the outer edges of the riparian vegetation, or to the extent of the seasonally saturated soil, or to the extent of moderately and highly unstable areas, or to a distance equal to the height of one site-potential tree, or 150 feet slope distance from the edge of the maximum pool elevation of constructed ponds and reservoirs, or from the edge of the wetland, pond or lake, whichever is greater.

Seasonally flowing or intermittent streams, wetlands less than 1 acre, landslides, and landslide-prone areas: This category includes features with high variability in size and site-specific characteristics. At a minimum, the riparian habitat protection zones must include:

1. the extent of landslides and landslide-prone areas;

2. the intermittent stream channel and the area to the top of the inner gorge;

3. the intermittent stream channel or wetland and the area to the outer edges of the riparian vegetation;

4. the area from the edges of the stream channel, wetland, landslide, or landslide-prone area to a distance equal to the height of one site-potential tree, or 150 feet slope distance, whichever is greater;

In non-forested rangeland ecosystems, the riparian habitat protection zones width for permanently flowing streams is the extent of the 100-year flood plain.

Roadless and low-density roaded habitat protection zones: The roadless and low- density roaded area portions of habitat protection zones were developed by an interagency group (including the Forest Service, Bureau of Land Management, the National Marine Fisheries Service, and the U.S. Fish and Wildlife Service) addressing Federal lands within the Klamath River and Columbia River Distinct Population

Segments. Maps and lists of important roadless and low-density roaded area habitat protection zones are found in the Road Density Analysis Task Team Report (USDA *et al.* 2000a) for the Klamath River and Columbia River distinct population segments, but not for the other distinct population segments. Because the Klamath River and Columbia River distinct population segments maps were developed at the broad scale of two distinct population segments ranging across five States, a watershed analysis would not be sufficient to analyze the distinct population segment-wide issues associated with this set of roadless areas important for bull trout. Accordingly, the roadless and low-density roaded portions of the habitat protection zones should not be subject to change until an interagency team, including the U.S. Fish and Wildlife Service, conducts a basin-wide assessment to determine which, if any, roadless and low-density roaded area portions of habitat protection zones should be modified.

3. Project Designs for Bull Trout Conservation

To protect and recover bull trout, Federal land managers should apply Project Designs for Bull Trout Conservation within all habitat protection zones and to projects and activities that would degrade conditions in habitat protection zones. Some Project Designs for Bull Trout Conservation apply both inside and outside of habitat protection zones, as specified in each Project Designs for Bull Trout Conservation. The Project Designs for Bull Trout Conservation address 10 management issues in habitat protection zones and associated areas: timber extraction, roads management, grazing management, recreation management, mineral mining management, fire and fuels management, lands, general riparian area management, watershed and habitat restoration, and fisheries and wildlife restoration. These issues and project design features are similar to PACFISH, INFISH, and the Northwest Forest Plan and associated biological opinions, and thus should be relatively easy to interpret and implement.

Timber Extraction:

1. Prohibit timber extraction, including fuel wood cutting, in habitat protection zones, except as described below.

> a. Apply silvicultural practices within habitat protection zones only to acquire desired vegetation characteristics where needed to attain bull trout biological needs. Allow timber extraction, including fuel wood cutting, in habitat protection zones only where present and future woody debris needs are met, where cutting would not retard or prevent attainment of other biological needs, and where adverse effects on bull trout can be fully avoided.

b. Complete watershed analysis prior to timber extraction, including fuel wood collection, in habitat protection zones. Extract timber and apply silvicultural practices only if watershed analysis identifies a method that would not retard attainment of bull trout biological needs and that would fully avoid adverse effects on bull trout and impacts on their habitat, either occupied or unoccupied.

2. Analyze and address the cumulative, landscape-level effects of past and proposed timber extraction in the context of the natural and human-induced disturbances at various scales, including the subbasin, watershed, and subwatershed. Assure that as a result of proposed management, frequency, magnitude, duration of peak flows, and other disturbances to aquatic habitat do not result in adverse effects on bull trout or core habitat.

As discussed in the recovery plan, removal of live trees and associated road construction causes hydrologic and erosional changes that include alteration of the timing, volume, and duration of peak flows and transport of sediment as bedload. The amount and types of changes tree removal and road construction may cause depend upon climate, and the location and size of these actions in relation to streams, draws, and other topographic, soil, and geological features of an area. Because these features vary, any potential for hydrologic changes following proposed timber harvest and road construction should be analyzed using locally adapted models selected by level 1 teams (formed under the interagency Guidance for Streamlining Consultation Procedures Under Section 7 of the Endangered Species Act; USDA *et al.* 1997a) and applied at local analysis levels (subbasin, watershed, and project) as part of the section 7 consultation process. We are aware of several cumulative effects analysis procedures and models (*e.g.*, Potts *et al.* 1989; Nakama and Risley 1993; and many reviewed in Reid 1993), but are also aware that none are widely accepted and used. To understand and predict the effects from existing and planned timber extraction, the U.S. Fish and Wildlife Service recommends that land managers apply models adapted to or developed for site-specific conditions. In the absence of locally-adapted models, apply the method below to start addressing an index of cumulative effects in section 7 consultation:

A. Using methods accepted for the area, calculate the equivalent clear-cut acreage for each subbasin, watershed, and subwatershed within which timber extraction is proposed.

B. Compare the calculated equivalent clear-cut acreage values for watersheds and subwatersheds to the appropriate values in the table below. If the proposed timber extraction would increase the equivalent clear-cut acreage above any of the applicable values listed below, then proceed only with part of the action that will achieve an equivalent clear-cut acreage less than the value(s) in the table.

If analysis determines, as affirmed by level 1 teams, that bull trout habitat is maintained at an equivalent clear-cut acreage value different than from the table, then use that value whether it is higher or lower than the value in the table.

C. Use the results of these basic calculations along with other aspects of bull trout recovery needs to prioritize local evaluations and recovery actions relating to cumulative effects from timber harvest and associated roads.

We understand that this approach to addressing cumulative effects is not the most sophisticated available. However, this appendix addresses the entire United States range of bull trout, including places where sophisticated, locally-developed models do not exist. We used a simple, unified approach as a first step toward addressing a cumulative effects index for timber extraction during section 7 consultation. In addition, we are fully aware that negative direct and indirect effects from various mechanisms can result from timber extraction at levels well below the equivalent clear-cut acreage values indicated in the table. Those direct and indirect effects will be fully considered in other analysis procedures during section 7 consultation, although they may not be apparent in this basic cumulative effects index.

We will generally rely on this basic index as an indicator of where the effects of proposed actions, together with cumulative effects, may be incompatible with bull trout recovery, unless other models with full level 1 team support exist.

Roads Management

1. Cooperate with Federal, Tribal, State, and county agencies, and cost-share partners to achieve consistency in road use and maintenance necessary to attain bull trout biological needs.

2. For each existing road, meet the bull trout biological needs and avoid adverse effects on bull trout by:

A. Developing and implementing an Existing Road and Transportation Management Plan. Address these items in the plan:

i. Road management objectives for each existing road.

ii. Criteria that govern road operation, maintenance, and management.

iii. Requirements for pre-, during-, and post-storm inspections and maintenance.

iv. Regulation of traffic during wet periods to minimize erosion and sediment delivery and accomplish other objectives.

v. Implementation and effectiveness monitoring plans for road stability, drainage, and erosion control.
vi. Emergency repair plans for road failures.

B. Avoiding sediment delivery to streams from existing road surfaces.

i. During maintenance grading or resurfacing, outslope the roadway surface except in cases where outsloping would increase sediment delivery to streams or where outsloping is infeasible or unsafe.
ii. Route road drainage away from potentially unstable stream channels, fills, and hillslopes.

C. Avoid disruption of natural hydrologic flow paths including overland, subsurface, and groundwater.

D. Avoid sidecasting snow. Prohibit sidecasting of road material on road segments within or abutting habitat protection zones in all bull trout recovery units.

3. Determine the influence of each existing road on bull trout biological needs. Meet bull trout biological needs and avoid adverse effects on bull trout by:

A. Reconstructing road and drainage features that do not meet design criteria or operation and maintenance standards, or that have been shown to be less effective than designed for controlling sediment delivery, or that retard attainment of bull trout

biological needs, or do not protect bull trout from sedimentation elevated above levels where bull trout biological needs can be achieved.

B. Close and stabilize or obliterate and stabilize roads not needed for future management activities. Prioritize these actions based on the current and potential damage to bull trout habitat and the ecological value of the riparian resources affected.

4. Improve existing and new culverts, bridges, and other stream crossings to accommodate a 100-year flood, including associated bedload and debris. Base priority for upgrading on risks to bull trout and the ecological value of the riparian resources affected. Construct and maintain crossings to prevent diversion of streamflow out of the channel and down the road in the event of crossing failure.

5. Provide and maintain bull trout passage at all road crossings of existing and potential fish-bearing streams. Where passage is blocked and may be preventing brook trout from invading bull trout habitat, consider the potential effects of brook trout introduction prior to removing passage barriers that separate bull trout from brook trout.

6. In areas outside roadless and low-density roaded area habitat protection zones, reconstruct roads or construct new roads within riparian habitat protection zones only if all three of these conditions are met:

> A. If at least two times the road area (road length times road width, including cutbank and sidecast) constructed is obliterated concurrently or prior to the construction;
>
> B. If watershed analysis, other scientifically sound site-specific analysis, and section 7 consultation at the watershed-scale predict the net effect of construction and obliteration would appreciably reduce long-term sedimentation or other adverse effects of roads; and
>
> C. Bull trout local populations can withstand the short-term effects and are predicted to respond to the long-term habitat improvements.

7. Do not construct or reconstruct roads in roadless and low-density roaded area habitat protection zones identified in the Road Density Analysis Task Team Report (USDA *et al.* 2000d).

> A. The effects of roads on bull trout habitat is well documented. Roadless and low-density roaded areas constitute watersheds or portions of watersheds unaltered by the effects of roads. Roadless and low-density roadless habitat protection zones can provide stability to anchor recovery efforts within larger areas. The stability of roadless and low-density roaded habitat protection zones should not be jeopardized by introducing the negative effects of roads.
>
> B. As discussed in the recovery plan, the recovery team has reviewed the literature on the effects of fires and the effects of roads. In general, the effects of all types of fires on Federal lands, including stand-replacing fires in areas where stand-replacing fires historically did not occur, generally pose less risk to bull trout than the long-term, chronic effects of roads on Federal lands. For that reason, construction of roads to prevent fires is not a valid approach to conservation of bull trout and their habitats on Federal lands.

8. Determine the road density on a linear mile per square mile basis (mile/mile^2) for all roaded areas in a watershed. Lee *et al.* (1997) indicate that most strong bull trout populations occur where road densities are 0.45 mile/mile^2 or less.

A. Where road densities exceed 0.45 mile/mile^2, transportation management plans should identify and implement strategies to reduce road density. Implement restoration actions to reduce road densities such that roads, road segments, or other road-related features (*i.e.*, culverts or crossings) that pose the highest risks to bull trout habitat are addressed first. Prioritize and identify road risks through application of Roads Analysis. Appropriate road density targets and specific road obliteration actions should be developed as part of peer reviewed watershed analysis.

In addition, do not build additional roads in areas or watersheds where road density is greater than 0.45 mile/mile^2 unless:

i. Watershed analysis has determined that increased road density will not adversely affect bull trout or their biological needs, even in presently unoccupied habitat, or

ii. Construction is preceded by or concurrent with an equal or greater length of road obliteration elsewhere in the watershed or subwatershed and is consistent with the road density reduction plan.

B. For roaded areas with road densities less than 0.45 mile/mile^2, create and implement a plan to assure road densities do not approach or exceed 0.45 mile/mile^2 or another value determined to be appropriate by the peer reviewed watershed analysis for the watershed.

Grazing Management

1. Modify grazing practices (*e.g.*, accessibility of riparian areas to livestock, length of grazing season, stocking levels, timing of grazing, etc.) that retard or prevent attainment of bull trout biological needs or are likely to adversely affect bull trout. Suspend grazing if adjusting practices is not effective in meeting bull trout biological needs and avoiding adverse effects on bull trout.

2. Locate new livestock handling and management facilities outside of riparian habitat protection zones. For existing livestock handling facilities inside the riparian habitat protection zones, assure that facilities do not prevent attainment of bull trout biological

needs or adversely affect bull trout. Relocate or close facilities where these objectives cannot be met.

3. Limit livestock trailing, bedding, watering, salting, loading, and other handling efforts to those areas and times that will not retard or prevent attainment of bull trout biological needs or adversely affect bull trout.

4. Adjust wild horse and burro management to avoid negative effects that prevent attainment of bull trout biological needs or adversely affect bull trout.

5. Include riparian habitat protection zones in a separate pasture with separate management objectives and strategies than the rest of the allotment.

6. Fence or herd livestock out of riparian areas for as long as necessary to allow vegetation and stream banks to recover.

7. Control the timing of grazing to: (a) keep livestock off stream banks when they are most vulnerable to damage; and (b) coincide with the physiological needs of target plant species.

8. Add more rest to the grazing cycle to increase plant vigor, allow stream banks to heal, or encourage more desirable plant species composition.

9. Limit grazing intensity to a level that will maintain desired species composition and vigor.

10. Permanently exclude livestock from riparian habitat protection zones or streambank areas at high risk and with poor recovery potential when there is no practical way to protect them while grazing adjacent uplands.

11. Implement changes consistent with monitoring results. Monitor consistent with the Range Resource Implementation Monitoring Module and Effectiveness Monitoring Modules (USDA and USDI 1998; USDA *et al.* 1999 a,b,c,d).

Recreation Management

1. Design, construct, and operate recreation facilities, including trails and dispersed sites, in a manner that does not retard or prevent attainment of bull trout biological needs and avoids adverse effects on bull trout.

> A. Construct new recreation facilities in habitat protection zones only if watershed analysis, other scientifically sound site-specific analysis, and section

7 consultation at the watershed-scale unequivocally predict the long-term effects are fully compatible with bull trout protection and recovery; and

B. For existing recreation facilities inside habitat protection zones, assure that the facilities or use of the facilities will not prevent attainment of bull trout biological needs

or adversely affect bull trout. Relocate or close existing recreation facilities where bull trout biological needs cannot be met or adverse effects on bull trout cannot be avoided.

2. Adjust dispersed and developed recreation practices that retard or prevent attainment of bull trout biological needs or adversely affect bull trout. Where adjustment measures such as education, use limitations, traffic control devices, increased maintenance, relocation of facilities, and specific site closures are not effective in meeting bull trout biological needs and avoiding adverse effects on bull trout, eliminate the practice or occupancy.

3. Achieve attainment of bull trout biological needs and potential effects on bull trout in Wild and Scenic Rivers, Wilderness, and other Recreation Management plans.

Mineral Mining Management

1. Avoid adverse effects to bull trout habitat from mineral mining operations. If a mineral operation is located in a habitat protection zones, or could affect attainment of bull trout biological needs, or adversely affect bull trout, require a reclamation plan, approved plan of operations (or other such governing document), and reclamation bond. For effects that cannot be avoided, such plans and bonds must address the costs of removing facilities, equipment, and materials; recontouring disturbed land to near pre-mining topography; isolating and neutralizing or removing toxic or potentially toxic materials; salvage and replacement of topsoil; and seed bed preparation and revegetation to attain bull trout biological needs and avoid adverse effects on bull trout. Ensure reclamation plans contain measurable attainment and bond release criteria for each reclamation activity.

2. Locate structures, support facilities, and roads outside habitat protection zones. Where no alternative to situating facilities in habitat protection zones exists, locate and construct the facilities in ways that avoid negative effects to habitat protection zones and streams and adverse effects on bull trout.

A. Where no alternative to road construction exists keep roads to the minimum necessary for the approved mineral activity and obliterate two times the road area constructed.

B. Close, obliterate, and revegetate roads no longer required for mineral or land management activities.

3. Prohibit solid and sanitary waste facilities in habitat protection zones. If no alternative to locating mine waste (waste rock, spent ore, tailings) facilities in habitat protection zones exists, and releases can be prevented and stability can be ensured, then:

A. Analyze the waste material using the best conventional sampling methods and analytic techniques to determine its chemical and physical stability characteristics.

B. Locate and design the waste facilities using the best conventional techniques to ensure mass stability and prevent the release of acid or toxic materials. If the best conventional technology is not sufficient to prevent such releases and ensure stability over the long term, prohibit such facilities in habitat protection zones.

C. Monitor waste and waste facilities to confirm predictions of chemical and physical stability, and make adjustments to operations as needed to avoid adverse effects to bull trout and to attain bull trout biological needs.

D. Reclaim and monitor waste facilities to assure chemical and physical stability and revegetate to avoid adverse effects on bull trout and to attain bull trout biological needs.

E. Require reclamation bonds adequate to ensure long-term chemical or physical stability and successful revegetation of mine waste facilities.

4. For leasable minerals, prohibit surface occupancy within habitat protection zones for oil, gas, and geothermal exploration and development activities where contracts and leases do not already exist. Adjust the operating plans of existing contracts to (A) eliminate negative effects that prevent attainment of bull trout biological needs and (B) avoid adverse effects to bull trout.

5. Prohibit sand and gravel mining and extraction within habitat protection zones.

6. Develop inspection, monitoring, and reporting requirements for mineral mining activities. Evaluate and apply the results of inspection and monitoring to modify mineral plans, leases, or permits as needed to eliminate negative effects that prevent attainment of bull trout biological needs and avoid adverse effects on bull trout.

Fire and Fuels Management

1. Design fuel treatment and fire suppression strategies, practices, and actions so as not to prevent attainment of bull trout biological needs, and to minimize disturbance of riparian ground cover and vegetation. Strategies should recognize the role of fire in ecosystem function and identify those instances where fire suppression or fuel management actions could be damaging to long-term ecosystem function, or bull trout biological needs.

2. Use an interdisciplinary team, including a fishery biologist, to identify incident base and helibase locations during pre-suppression planning, with avoidance of potential adverse effects to bull trout as a primary goal. Locate incident bases, camps, helibases, staging areas, helispots, and other centers for incident activities outside of habitat protection zones. If the only suitable location for such activities is within habitat protection zones, locate there and follow recommendations from a fishery resource advisor. The fishery advisor will prescribe the location, use conditions, and rehabilitation requirements, with avoidance of adverse effects to bull trout as a primary goal.

3. Avoid delivery of chemical retardant, foam, or additive to surface waters. An exception may be warranted in situations where overriding immediate safety imperatives exist.

4. Design prescribed burn projects and prescriptions to contribute to the attainment of bull trout biological needs.

5. Immediately establish an emergency team to develop a rehabilitation treatment plan to attain bull trout biological needs and avoid adverse effects on bull trout whenever habitat protection zones are substantially damaged by a wildfire or a prescribed fire burning out of prescription.

Federal Public Lands Property Management

1. Require instream flows and habitat conditions for hydroelectric and other surface water development proposals that maintain or restore riparian resources, favorable

channel conditions, and fish passage, reproduction, and growth. Coordinate this process with the appropriate State agencies. During relicensing of hydroelectric projects, provide written and timely license conditions to the Federal Energy Regulatory Commission that require fish passage and flows and habitat conditions that maintain and restore riparian resources and channel integrity. Coordinate relicensing projects with the appropriate State agencies.

2. Locate new hydroelectric ancillary facilities outside habitat protection zones. For existing ancillary facilities inside the habitat protection zones that are essential to proper management, provide recommendations to the Federal Energy Regulatory Commission to assure that the facilities will not prevent attainment of bull trout biological needs and that adverse effects on bull trout are avoided. Where these objectives cannot be met, provide recommendations to the Federal Energy Regulatory Commission that such ancillary facilities should be relocated. Locate, operate, and maintain hydroelectric facilities that must be located in habitat protection zones to avoid effects that would retard or prevent attainment of bull trout biological needs and avoid adverse effects on bull trout.

3. Issue leases, permits, rights-of-way, and easements to avoid effects that would retard or prevent attainment of bull trout biological needs and avoid adverse effects on bull trout. Adjust existing leases, permits, rights-of-way, and easements to eliminate effects that would retard or prevent attainment of bull trout biological needs or adversely affect bull trout. If adjustments are not effective, eliminate the activity. Base priority for modifying existing leases, permits, rights-of-way, and easements on the current and potential adverse effects on bull trout and the ecological value of the riparian resources affected.

4. Use land acquisition, exchange, and conservation easements to meet bull trout biological needs and facilitate restoration of bull trout.

General Riparian Area Management

1. Identify and cooperate with Federal, Tribal, State and local governments to secure instream flows needed to maintain riparian resources, channel conditions, and aquatic habitat.

2. Trees felled in habitat protection zones because they pose a safety risk for recreation areas should be kept on site.

3. Apply herbicides in a manner that does not retard or prevent attainment of bull trout biological needs and avoids adverse effects on bull trout. Do not apply insecticides or other toxins in habitat protection zones and avoid application of herbicides within

habitat protection zones whenever possible. Avoid the introduction of any herbicide, insecticide, or other toxins into waterways.

4. Prohibit storage of fuels and other toxins within habitat protection zones. Prohibit refueling within habitat protection zones.

5. Locate water drafting sites to avoid adverse effects to bull trout and instream flows, and in a manner that does not retard or prevent attainment of bull trout biological needs.

Watershed and Habitat Restoration

1. Design and implement watershed restoration projects in a manner that promotes the long-term ecological integrity of ecosystems, conserves the genetic integrity of native species, and contributes to attainment of bull trout biological needs.

2. Cooperate with Federal, State, local, and Tribal agencies, and private landowners to develop watershed resource management plans or other cooperative agreements to meet bull trout biological needs.

3. Do not use planned restoration as a substitute for preventing habitat degradation (*i.e.*, use planned restoration only to mitigate existing problems not to mitigate the effects of proposed activities).

Fisheries and Wildlife Restoration

1. Design and implement fish and wildlife habitat restoration and enhance actions in a manner that contributes to attainment of bull trout biological needs.

2. Design, construct, and operate fish and wildlife interpretive and other user-enhancement facilities in a manner that does not retard or prevent attainment of bull trout biological needs or adversely affect bull trout. For existing fish and wildlife interpretive and other user-enhancement facilities inside habitat protection zones assure that bull trout biological needs are met and adverse effects on bull trout are avoided. Where bull trout biological needs cannot be met or adverse effects on bull trout avoided, relocate or close such facilities.

3. Cooperate with Federal, Tribal, and State fish management agencies to identify and eliminate adverse effects on bull trout associated with habitat manipulation, fish stocking, fish harvest, and poaching.

4. Conduct watershed analysis and subbasin analysis and use results to design management plans and actions.

Subbasin analysis and watershed analysis are systematic procedures for determining how subbasins and watersheds function in relation to physical and biological components. This is accomplished through consideration of history, processes, landform, and condition. Watershed analysis should follow the final guidance on "Ecosystem Analysis at a Watershed Scale, Federal Guide for Watershed Analysis" (often referred to as the "Federal Guide"; USDA *et al.* 1995). Currently there are two memoranda available (dated November 1, 1995 and October 16, 1996) that include new information and modules to be used. In addition, there is a draft riparian module (February 1997) specific to intermittent streams.

Watershed analysis is a prerequisite for determining which processes and parts of the landscape affect fish and riparian habitat, and is essential for defining watershed-specific boundaries for habitat protection zones and for bull trout biological needs. Watershed analysis can form the basis for evaluating cumulative watershed effects; defining watershed restoration needs, goals, and objectives; implementing restoration strategies; and monitoring the effectiveness of watershed protection measures, depending upon the issues to be addressed in the watershed analysis.

5. Use implementation and effectiveness monitoring to determine if:

a) Actions on federally managed lands implemented recovery tasks or followed the Project Designs for Bull Trout Conservation; and

b) Recovery tasks or Project Designs for Bull Trout Conservation successfully protect and contribute to the recovery of bull trout.

The recovery plan describes the need for monitoring. Monitoring is necessary to determine the effectiveness of recovery tasks and Project Designs for Bull Trout Conservation. If degradation continues after recovery tasks or Project Designs for Bull Trout Conservation are implemented, then we could conclude they are not effective in bringing about recovery, and make changes to increase the chances for recovery. Many different monitoring strategies have been developed over the years. Strategies developed in the recovery plan and in the Monitoring Modules resulting from the Interagency Implementation Team for the Biological Opinion on PACFISH and INFISH should continue to be used and new modules developed for implementation and effectiveness monitoring.

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APPENDIX 3: EFFECTIVE POPULATION SIZE AND RECOVERY PLANNING

(References included in the Literature Cited section of the plan.)

Effective population size provides a standardized measure of the amount of genetic variation that is likely to be transmitted between generations within a population. Effective population size is a theoretical concept that allows one to predict potential future losses of genetic variation within a population due to small population size and genetic drift. Individuals within populations with very small effective population sizes are also subject to *inbreeding depression* because most individuals within small populations share one or more immediate ancestors (parents, grandparents, etc.) after only a few generations and will be closely related.

A number of factors affect the effective population size of a species. For example, unequal sex ratios can significantly affect effective population size because male and female adults of the parent generation must each contribute 50 percent of the genes to the progeny generation regardless of their relative numbers. Hence, effective population size will be lower than the summed census number of both sexes, and will also be less than four times as large as the number of adults of the less common sex. For example, a population derived from one male and three females would have an effective population size of three; a population derived from one male and an infinite number of females would have an effective population size of four (Crow and Kimura 1970). The latter population would experience the same amount of genetic drift as a population derived from only 2 males and 2 females. Similarly, populations with high fluctuations in abundance over time (or generations) will have an effective population size that is approximated by the harmonic mean of the effective population sizes of each generation. This harmonic mean will be influenced significantly by the generation with the lowest effective population size because that generation represents the "bottleneck" through which all genetic variation in future generations must pass.

It is relatively easy to relate effective population size to theoretical losses of genetic variation in future generations and, thus, provide conservation guidelines for effective population size. Based on standardized theoretical equations (Crow and Kimura 1970), the following guidelines have been established for maintaining minimum effective population sizes for conservation purposes:

- Effective Population Size > 50 to prevent inbreeding depression and a potential decrease in viability or reproductive fitness of a population (Franklin 1980);

- Effective Population Size > 500 to minimize loss of genetic variation due to genetic drift and maintain constant genetic variance within a population resulting from a balance between loss of variance due to genetic drift and an increase in variance due to new mutations or gene migration (Franklin 1980; Soule 1980; Lande 1988);

- Effective Population Size > 5,000 to maintain constant variance for quasi-neutral, genetic variation that can serve as a reservoir for future adaptations in response to natural selection and changing environmental conditions (Lande 1995). The rationale here is that the effective population size needs to be large enough to minimize genetic drift and the potential loss of genetic material that may confer a slight, selective advantage under existing or future environmental conditions.

In contrast to establishing conservation guidelines for effective population size, it is much more difficult to quantitatively relate the breeding structure of a species and census numbers of populations to effective population size so that the 50/500/5000 guidelines can be applied at the appropriate scale. The longevity, life histories, and structure of individual breeding units (*i.e.*, *local populations*) must be understood sufficiently to relate the number of observed adults within a particular population (and in a particular generation) to a genetic *effective number of breeders*. Conceptually, this latter quantity will be similar to effective population size in the classical, textbook sense. Second, it is necessary to understand the amount of gene flow among geographically adjacent breeding units (*e.g.*, bull trout reproducing in adjacent tributaries to a river) so that, over multiple-generation time-scales, effective breeding numbers at the local population level can be considered part of a larger *metapopulation* with respect to applying the 50/500/5000 guidelines. For example, very small amounts of gene flow may not be sufficient to increase the effective number of breeders within a given local population above effective population equal to 50. However, in a combination of such populations that experience gene flow between them, effective breeding numbers for the metapopulation may be greater than 500. In this latter situation, one would predict significant genetic variation among breeding units and comparatively small amounts of genetic variation within individual breeding units, but the combination (or metapopulation) as a whole could potentially retain significant amounts of genetic variation over time. The key to understanding the evolutionary and conservation implications of such a breeding structure is knowing whether the individual breeding units, or local populations, are completely isolated reproductively or whether some gene flow does indeed occur, thus allowing genetic material to be reintroduced if lost from a particular population.

The effective population size > 5,000 rule derived by Lande (1995) relates largely to future evolutionary potential. Hence, the scale for its application are expected, in most cases, to be much larger than the spatial and temporal scales at which one applies the “50/500" rules. For example, the effective population size > 50 and effective population size > 500 guidelines may be most applicable on time scales encompassing 1-5 and 5-50 generations, respectively: at least two generations are necessary to produce “inbred” individuals after a population has gone through a major population bottleneck (*i.e.*, effective population size < 50), and a substantially greater number of generations are usually necessary for genetic drift to be significant (*i.e.*, when effective population size < 500). On the other hand, the effective population size > 5,000 guideline relates to the evolutionary persistence of a species over some defined geographic area such that, if extinction does occur, recolonization from elsewhere is precluded geographically or is unlikely to occur over microevolutionary time scales (*e.g.*, 50 or more generations).

The effective population size > 5000 guideline would apply to a population unit that is significant from an evolutionary perspective. This population unit could range from a local population to multiple recovery units and theoretically should represent a distinct population segment. Based on the best genetic information available at the time of listing (1998), the U.S. Fish and Wildlife Service identified both the Columbia and Klamath rivers as distinct population segments (63 FR 31647). Additional genetic information since the time of listing indicates that subdivision of the current Columbia River distinct population segment into smaller units may be warranted. A research need has been identified to evaluate whether the Columbia River distinct population segment can be further divided. The bull trout recovery plan has identified the collection of genetic information and the potential re-classification of the Columbia River distinct population segment as a research need. Division of any additional distinct population segments will follow existing policy, and will consider both the discreteness, and significance of the proposed unit (61 FR 4722).

Rieman and Allendorf (2001) have performed computer simulations of bull trout populations to understand the relationship between the observed number of adults, or spawners, within a local population and effective population size. Their best estimate of effective population size is 0.5 to 1.0 times the mean number of adult fish spawning annually. This translates into maintaining between 50 and 100 spawners per year to minimize potential inbreeding effects within local populations. The spatial scale for such a local population would encompass all adult fish with approximately equal probability of interbreeding amongst themselves within a single year or generation. One would expect such a population to include very few immigrants from another population or breeding unit. Between 500 and 1,000 spawners per year would be needed to maintain genetic variation and minimize the deleterious effects of drift. The appropriate spatial for maintaining genetic variation for bull trout would be most frequently applied at the core area level.

APPENDIX 4: LIST OF CHAPTERS

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